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An Analysis of Alternative Policies for Dealing with New Source Growth in Nonattainment Areas: Oxidants Study Area: Philadelphia AQCR

Engineering-Science, Inc.
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This study evaluates the potential of five air pollution control strategies to meet ozone attainment deadlines in Philadelphia. The scenarios analyze: 1) pre-1979 regulations, 2) A State Implementation Plan (SIP) based on Reasonable Available Control Technology (RACT), 3) A RACT SIP which requires emission offsets for new sources, 4) A RACT SIP which allows no major source construction after 1979, and 5) A SIP which bans construction after 1979 and requires existing sources to retrofit with Lowest Achievable Emissions Rate (LAER) technology.

The study's major conclusions: 1) All 5 options ensure reasonable further progress toward attainment by 1982, 2) Largest reductions in emissions result from applying the RACT SIP scenario, 3) The offset scenario is only effective in high major source growth areas, 4) the RACT SIP scenario with no major source growth achieves nearly equivalent reductions as the 1:1 offset scenario, 5) The LAER replacement scenario achieves attainment, but the RACT SIP provides a greater incremental benefit to air quality, and 6) attainment is achievable with a RACT SIP if transport of emissions is insignifant.

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AN ANALYSIS OF ALTERNATIVE POLICIES FOR DEALING WITH NEW SOURCE GROWTH IN NONATTAINMENT AREAS

OXIDANTS

STUDY AREA: PHILADELPHIA AQCR

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TABLE OF CONTENTS

Chapter		Page
I	INTRODUCTION	I-1
	Description of Study Area	I-3
	Requirements of the 1977 Clean Air Act Amendments	I-7
	Description of Policy Options	I-10
	Sensitivity Analyses	I-14
	Description of the Methodology	I-15
	Assumptions and Limitations	I-19
II	SUMMARY AND CONCLUSIONS	II-1
	Reasonable Further Progess	II-1
	Attainment of the Standard	II-2
III	DATA INPUTS USED FOR ANALYSES	III-1
	Base Year Emission Inventories	III-1
	SIP Allowable Emissions	III-12
	Control Technology Definitions	III-13
	Growth in Emissions	III-14
	Availability of Offsets	III-16
	Growth and Replacement	III-16
IV	ESTIMATING THE REQUIRED EMISSION REDUCTIONS	IV-1
	Methods for Relating Ozone to Precursors	IV-2
	Reduction Required for Attainment	IV-4
	Reasonable Further Progress	IV-6
V	GROWTH AND PROGRESS TOWARD ATTAINMENT (1976-1982)	V-1
	I: Pre-1979 SIP with Major Source Construction	V-1
	II: RACT SIP with Major Source Construction	V-4
	III: RACT SIP with Offsets for New Major Source Construction	V-6
	IV: RACT SIP with No Major Source Construction After 1979	V-12
	V: LAER Replacement with No Major Source Construction After 1979	V-14
	Comparison of Projected Emissions	V-14
VI	POTENTIAL FOR ATTAINING STANDARD	VI-1
	Potential for Attainment	VI-1
	Sensitivity Analyses	VI-10

APPENDIX A: OZONE DESIGN VALUE FOR PHILADELPHIA
APPENDIX B: METHODOLOGY AND ASSUMPTIONS FOR CALCULATING EMISSION REDUCTIONS
APPENDIX C: EMISSION CONTROL DEFINITIONS
APPENDIX D: GROWTH AND RETIREMENT SCHEDULES
APPENDIX E: BASE YEAR AND PROJECTED EMISSION INVENTORIES
APPENDIX F: GLOSSARY OF TERMS

LIST OF ILLUSTRATIONS

Figure	Title	Page
I-1	Philadelphia Air Quality Control Region	I-4
I-2	Air Quality Monitoring Network	I-6
I-3	Study Methodology	I-16
III-1	Industrial Components of the 1976 Base Year Point Source Emission Inventory for Nonmethane Hydrocarbons	III-7
III-2	1976 Base Year Emission Inventory for Nonmethane Hydrocarbons	III-11
III-3	RACT/LAER Coverage Philadelphia AQCR	III-15
IV-1	Reasonable Further Progress and Potential for Attainment	IV-7
V-1	I: Pre-1979 SIP with Major Source Construction	V-3
V-2	II: RACT SIP with Major Source Construction	V-6
V-3	III: RACT SIP with Offsets for Major Source Construction	V-11
V-4	IV: RACT SIP with No Major Source Construction After 1979	V-13
V-5	V: LAER Replacement with No Major Source Growth After 1979	V-15
VI-1	I: Pre-1979 SIP with Major Source Construction	VI-2
VI-2	II: RACT SIP with Major Source Construction	VI-4
VI-3	III: RACT SIP with Major Source Construction with Offsets	VI-6
VI-4	Potential to Attain the Ozone Standard	VI-8

LIST OF TABLES

Table	Title	Page
I-1	Control Technology Assumptions Used for Policy Analyses	I-11
III-1	A Comparison of 1976 Actual, RACT, LAER, and Projected Additional Point Emissions by 1990 for Nonmethane Hydrocarbons	III-3
III-2	Input Parameters to Mobile 1 Emission Factor Calculations	III-9
III-3	Summary of Mobile and Stationary Area, Base Year Emissions and Projected Increments with Various Controls for Nonmethane Hydrocarbons	III-10
III-4	Changes in Availability of Offsets from Existing (1976) Point Sources Due to Scheduled SIP Revisions	III-17
IV-1	Example of Modified Rollback Calculation	IV-5
V-1	Analysis of Changes in NMHC Emissions Under the Emission Offset Policy Assuming Major Point Source Growth ≥ 50 tpy Requires Offsets and Growth is Steady in Time	V-8
V-2	Comparison of Projected Emissions with the Reasonable Further Progress Requirement Under Various Policy Options	V-16
VI-1	Comparison of 1987 NMHC Emissions for Various Policy Options	VI-9

CHAPTER I

INTRODUCTION

At the request of both the President and Congress, the U.S. Environmental Protection Agency (EPA) is undertaking a review of environmental policies in nonattainment air quality areas. At issue is how best to handle potential new source construction in areas currently exceeding the national ambient air quality standards (NAAQS), while ensuring expeditious attainment of the public health standards in a fair and effective manner.[1,2]

As a result of Congressional and Executive requests, EPA initiated several studies to evaluate the issues dealing with nonattainment as well as other related concerns. Philadelphia was selected as one of three study areas.

The purpose of this study was to evaluate policy alternatives. It was not intended to substitute for the more detailed planning and analysis which the state agencies are required to conduct in preparing a revision of their State Implementation Plans (SIP). However, the analysis is a simulation of what the state agencies would have to perform in developing strategies to further reduce emissions in the Philadelphia area. The study is summarized in three volumes. Volume I is an analysis of policy alternatives and their impact on air quality levels of ozone and Volumes II and III present parallel analyses for total suspended particulate (TSP) and oxides of nitrogen (NO_x), respectively.

The objective of this report (Volume I) was to evaluate the impact of various air pollution control strategies on future ozone levels. The original contract for this effort was started in February 1977 with the intent of

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[1] The President's Environmental Message directed EPA to "review the current regulations controlling the construction of new facilities in areas not yet attaining air quality standards to ensure that these regulations will not interfere with the expeditious attainment of air quality levels required to protect public health. EPA is instructed to recommend a fair and effective policy for meeting these standards in the future".

[2] H.R. 6161 directed the Administrator and National Commission on Air Quality separately to report to Congress on the "air quality health, welfare, economic, energy, and social effects" of the current Congressional, EPA, and alternate policies to deal with this issue. In the Conference Bill, this study provision for a further evaluation of the nonattainment problem appears as one of the required reports of the National Commission on Air Quality.

analyzing certain growth issues associated with the Clean Air Act. Therefore, most of the data contained in this document are representative of the 1975-1976 period. Since the passage of the Clean Air Act Amendments in 1977 and the submittal of State Implementation Plans in 1979, some changes have been made in the assumtions and methodology used in the study. However, the basic inventory data, estimates of new industrial emissions, and the degree of control technology available for these sources have not changed.

The analyses address two requirements of the Clean Air Act, namely the achievement of reasonable further progress and attainment of the new ozone standard.[1] It was assumed that air pollution control measures in existence or defined in new permits could be applied to all existing or new sources. The cost of controlling emissions even to rather stringent levels was not considered in this study.

Several control strategy policy alternatives were evaluated using the Philadelphia AQCR as a study area. Analyses were performed for a base case, four key policy options, and several sensitivity scenarios. The policy alternatives are defined in the latter part of this chapter. The Philadelphia study area was selected by EPA because of the need to consider a mature urban area with low growth and because of the existence of a well documented emission inventory. Nonmethane hydrocarbons (NMHC) were studied because of their role in forming ozone and because the primary ozone health standard was exceeded in the study area. In recent years, the peak one-hour ozone level has been as high as three times the new 0.12 ppm ozone standard. This made it quite obvious that substantial reductions in hydrocarbon emissions would be required to demonstrate attainment of the standard.

The remainder of this chapter summarizes the study approach, the assumptions and limitations of the study, the methodology used in the analyses, and the policy options. In addition, the report consists of five other chapters. Chapter II presents the conclusions of the study regarding ozone levels. Chapter III discusses the data used in the analysis, their origins, and the interpretations that were made in order to use the data in this study. Chapter IV summarizes the calculated reductions in NMHC emissions required to demonstrate reasonable further progress and attainment of the standard. Chapters V and VI present the resulting impacts of the policy studies on reasonable further progress and attainment, respectively. Detailed documentation, calculations, and original data used in the study are presented in six appendices to facilitate reading.

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[1] During the course of this study, EPA changed the oxidant standard of 0.08 ppm to 0.12 ppm, ozone. This study addresses the potential for attainment of the new ozone standard of 0.12 ppm. The potential for attainment with the old 0.08 ppm standard and an intermediate 0.10 ppm standard considered by EPA prior to promulgation of the 0.12 ppm standard is examined in a sensitivity analysis.

DESCRIPTION OF THE STUDY AREA

The EPA chose two representative ozone nonattainment metropolitan areas for an examination of alternative policies for dealing with new source growth: Houston-Galveston, and Philadelphia. The Philadelphia area was selected for use in this analysis because it repesents a northeastern U. S. city which is expected to have a low growth rate and its broad industrial mix differs from that of Houston.

Urban Character

The Metropolitan Philadelphia Interstate Air Quality Control Region is a mature manufacturing complex sprawling along the Delaware River from its mouth in Delaware Bay northeastward to the great bend at Trenton. It comprises 11 counties in 3 states; Bucks, Chester, Delaware, Montgomery, and Philadelphia Counties in Pennsylvania; Burlington, Camden, Gloucester, Mercer, and Salem Counties in New Jersey; and New Castle County in Delaware. The area comprises Air Quality Control Region (AQCR) No. 045 and is shown in Figure I-1. Deep water ports are found in Wilmington, Philadelphia, Camden, and Trenton and, in addition, the Schuylkill River is navigable for about 6.5 miles north of its confluence with the Delaware. The urban core lies along the rivers and population density and manufacturing-commercial activity diminishes with distance from the Delaware River, merging with agricultural activity in the outermost fringes of all counties except Philadelphia County.

The population in the 11-county area in 1975 was estimated to be 5.64 million.[1, 2, 3]

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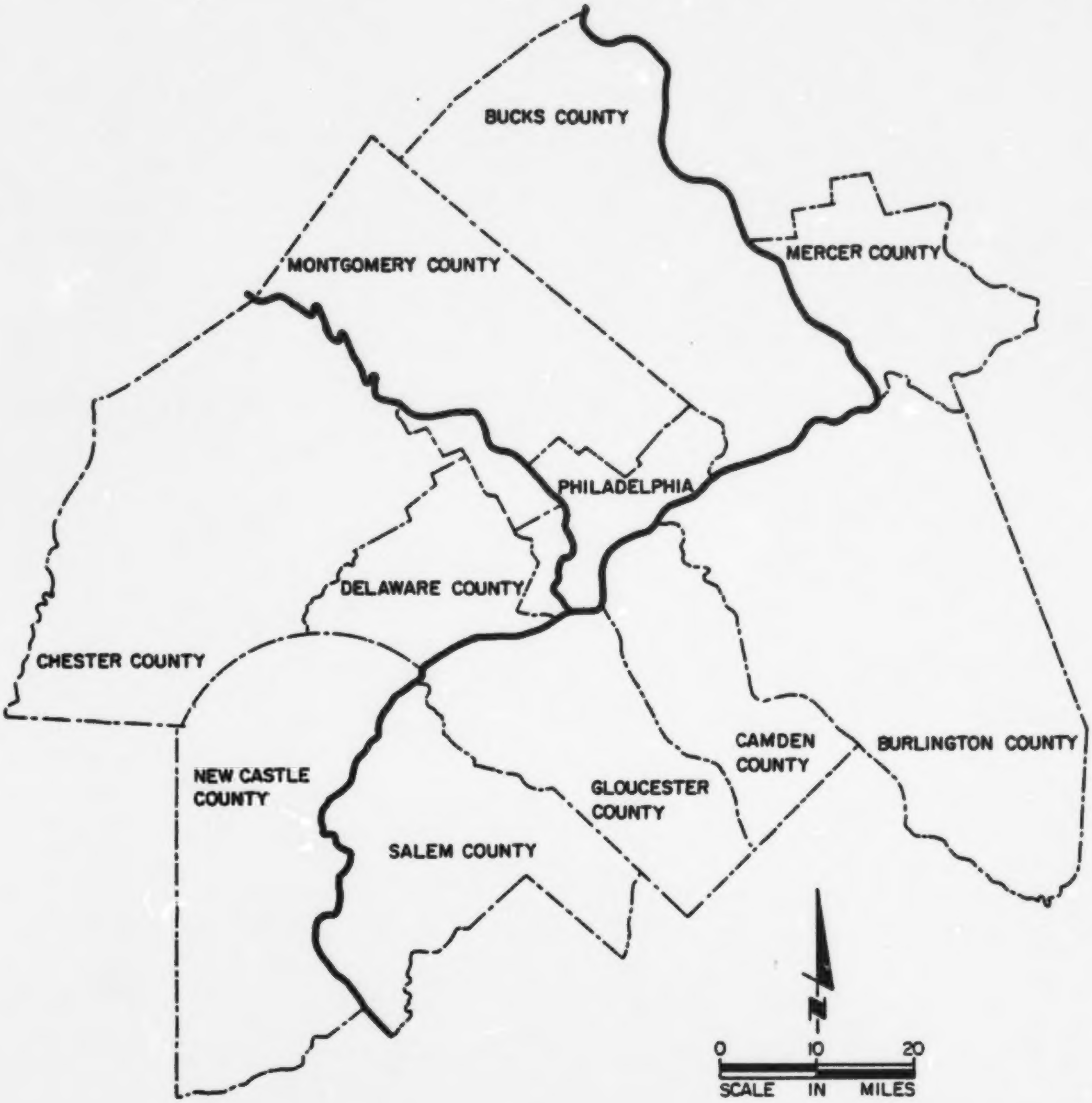
[1] Delaware Valley Data, No. 15, April 1977. Delaware Valley Regional Planning Commission.

[2] Population Estimates for New Jersey, Office of Business Economics, Dept. of Labor and Industry, P. O. Box 845, Trenton, N. J. 08625.

[3] Delaware Population Growth: 1975 Estimates and Projections to 1995 for the State and Major Civil Divisions, N. W. Rives, Jr. and C. H. Brown, Div. of Urban Affairs, University of Delaware, October 1975.

FIGURE I-1

PHILADELPHIA AIR QUALITY CONTROL REGION


BUCKS COUNTY
MONTGOMERY COUNTY
MERCER COUNTY
PHILADELPHIA
DELAWARE COUNTY
CHESTER COUNTY
CAMDEN COUNTY
BURLINGTON COUNTY
NEW CASTLE COUNTY
GLOUCESTER COUNTY
SALEM COUNTY
N
0
10
20
SCALE IN MILES

Population growth during the decade of the 1960s was on the order of 12%, most of it occurring in the suburban fringe. The urban core actually declined slightly in population in this interval (-2.7%). Manufacturing and commercial activity have experienced a similar migration with the nodes forming around shopping center malls. Meanwhile, the urban core activity has undergone a gradual transition from manufacturing toward increased highly specialized services: government, finance, business, health, and education.

For some time, the area has been a trade and distribution center. This area is still a travel crossroads for all transportation modes. The Delaware River, which is the principal axis of the urban area, is active with both domestic and foreign trading vessels; rails radiate from the axis in all directions; the Pennsylvania Turnpike, the New Jersey Turnpike, the Schuylkill Expressway, and Interstate 95 are major movers of motor vehicular traffic through the area; and major airports serve the area at Wilmington, Philadelphia International, and North Philadelphia.

Air Quality

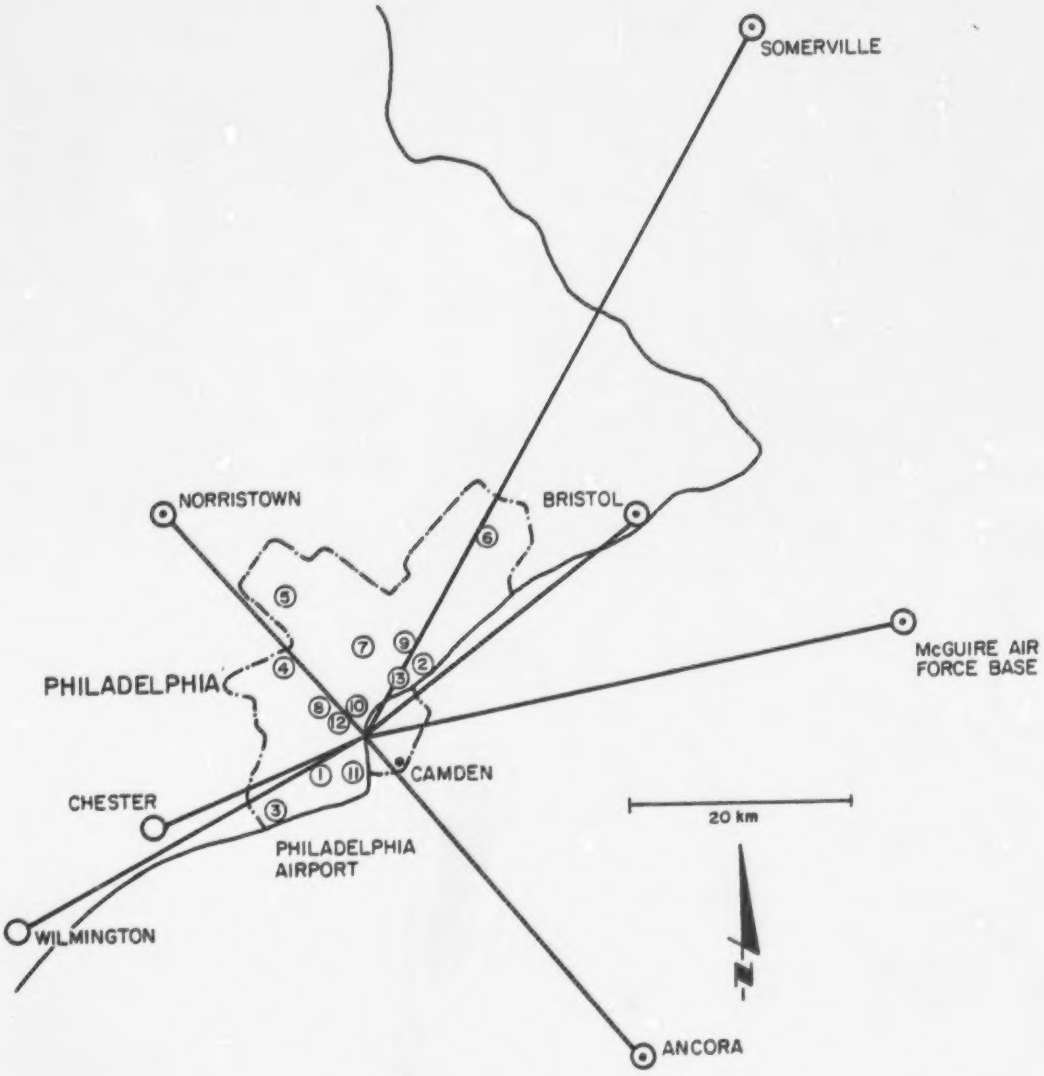
The formation of ozone is the result of complex interactions of nonmethane hydrocarbons and oxides of nitrogen in the presence of sunlight. The reaction generally proceeds within the urban plume as the urban effluent is carried downwind. Thus, the maximum ozone production is not reflected by the measurements within Philadelphia County but those some distance downwind, often outside the AQCR itself.

The monitoring stations maintained by the three state agencies around the urban core are shown in Figure I-2. Extreme observations above 0.30 ppm (maximum one-hour concentration) have been recorded. Air quality within Philadelphia County is measured by the Philadelphia Air Management Services, Department of Public Health. Their air quality monitoring network is also shown in Figure I-2. Here, the former oxidant standard of 0.08 ppm has been exceeded over 100 hours/year at most locations. The hydrocarbon precursor guide, 0.24 ppm average from 6-9 AM, has been exceeded from 200 to 300 times per year for the past five years. More detail on ambient air quality levels in the study area is provided in Appendix A.

The 1977 Amendments to the Clean Air Act required that each state submit to EPA lists of areas which on August 7, 1977 did not meet a primary National Ambient Air Quality Standard (NAAQS), which had air quality better than any

FIGURE I-2

AIR QUALITY MONITORING NETWORK *


SOMERVILLE
NORRISTOWN
BRISTOL
McGUIRE AIR FORCE BASE
PHILADELPHIA
CAMDEN
CHESTER
PHILADELPHIA AIRPORT
WILMINGTON
ANCORA
20 km
N
①
②
③
④
⑤
⑥
⑦
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⑬

* The air quality monitoring network around the Philadelphia AQCR. Numbered Sites are urban core sites maintained by Philadelphia AMS. (Appendix A).

NAAQS, or for which there was not sufficient data for classification. At that time, the oxidant NAAQS was 0.08 ppm (one hour average), not to be exceeded more than once per year. On March 3, 1978, EPA published a list of those areas of the country which were not attaining NAAQS's.[1] All of the counties within the Philadelphia AQCR (as depicted in Figure I-1) were designated as not meeting the primary ambient air quality standard for oxidants of 0.08 ppm. In accordance with the Clean Air Act Amendments, the states were to have developed and submitted to EPA revised oxidant SIPS's by January 1, 1979. However, in January 1979, EPA revised the oxidant standard from 0.08 ppm to an ozone standard of 0.12 ppm. As a result of this revision, the air quality data for all designated nonattainment areas were re-examined. But, this review revealed that the aforementioned counties were still nonattainment for ozone. Revised SIP's which reflect the new ozone standard have been developed and submitted to EPA by the respective state air pollution control agencies.

Growth Trends

The Delaware Valley Regional Planning Commission (DVRPC) suggests moderate growth will take place on a regional basis clustered around existing nodes. Their population projections over the 1970-2000 interval show an increase of only 16% while employment projections show an increase of 27%.[2] Specific industry forecasts, however, are needed for a study such as this and reliable forecasts were difficult to obtain. Appendix D describes the wide range of growth projections obtained and the manner of selecting those used in the study.

REQUIREMENTS OF THE 1977 CLEAN AIR ACT AMENDMENTS

The relevant requirements for nonattainment areas as set forth in the 1977 Clean Air Act Amendments can be summarized in four basic categories: reasonably available control technology, demonstration of attainment by new statutory attainment dates, reasonable further progress, and mechanisms to handle major source growth.

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[1] Federal Register, Vol. 43, No. 43, Friday, March 3, 1978.

[2] Year 2000 Regional Development Guide Data Bank for Transportation Planning, Tech. Report No. 3, Delaware Valley Regional Planning Commission, September 1977.

Reasonably Available Control Technology

The 1970 Clean Air Act required states to develop State Implementation Plans (SIPs) to attain and maintain national ambient air quality standards. These plans established emission limitations and other requirements as necessary to meet standards by the specified attainment dates. In nonattainment areas, revised SIPs were to have been submitted by January 1979 so that EPA could approve them by July 1979. The revised plans are required to impose measures representing reasonable available control technology (RACT) on stationary sources (see more detailed definition in Appendix F) and transportation strategies (reasonably available control measures) for mobile sources. Inspection and maintenance (I/M) programs for automobiles are necessary in areas which require extensions of up to 5 years to attain the ozone standard as described below.

Demonstration of Attainment by New Statutory Attainment Dates

Stage 1: 1979-1982

National ambient air quality standards must be attained as expeditiously as practicable. The 1977 Clean Air Act Amendments extended the statutory attainment dates to no later than December 31, 1982 for all pollutants. In the case of photochemical oxidants (ozone) and carbon monoxide, Congress recognized the difficulty that areas with problems related to those two pollutants would have in demonstrating attainment by the earlier date. In such cases, an additional five years, to December 31, 1987, is permitted. If the additional five-year extension is needed, the state must submit a RACT SIP in 1979 and provide a list of additional measures necessary to demonstrate attainment by 1987.

Stage 2: 1982-1987

Where an extension has been granted, the state must adopt by 1982 the remaining enforceable measures necessary to attain standards by 1987 for photochemical oxidants (ozone) and/or carbon monoxide.

Sanctions

If a state is unable to submit a SIP that can demonstrate attainment of national standards and which can be approved by EPA, specific sanctions are invoked under the Act including no major source construction after July 1979 and restrictions on federal funds for highways and wastewater treatment facilities.

Reasonable Further Progess

Prior to attainment of standards, the Clean Air Act Amendments call for interim progress in emission reductions on an annual basis, preferably in equal annual emmissions reductions which will provide for attainment by the statutory dates. There is an explicit requirement that to the extent possible these reductions should be realized in early years.

Mechanism for Handling Major Source Growth

Growth must take place within the framework of a plan which will achieve health based standards.

Prior to July 1979, the EPA offset ruling is in effect. There are two key conditions to the offset ruling:

- o For every ton of emissions from a new source, there must be an offsetting emission reduction from existing sources sufficient to represent reasonable further progress (RFP) towards attainment; and
- o New sources must meet the lowest achievable emission rate (LAER) which is the lowest rate achieved in practice or the lowest emission limitation set forth by any SIP for that same class or category of sources.

After July 1979, states are given a choice of two options as to how to handle new growth. The state can either:

- o Create a quantitative margin for growth within the SIP by imposing emission limitations on existing sources to a greater degree than minimally necessary to meet standards; or
- o Continue some form of case by case emissions offset approach.

In many cases, the states will provide for a combination of both approaches. With either option, new major sources must meet LAER.

As will be discussed below, the first of these requirements, reasonably available control technology, is assumed to be part of each of the policy options under study. The fourth element under the Clean Air Act Amendments, mechanisms for handling new major source growth, will vary amongst the policy options. The second and third elements of the 1977 Clean Air Act Amendments are used to evaluate each polity option in light of its ability to meet these two requirements: reasonable further progress and demonstration of attainment by the new statutory dates. In order to evaluate the extent to which policy options meet these two criteria, these requirements are interpreted with respect to current EPA policy in general and how they apply to the case study area in particular.

DESCRIPTION OF POLICY OPTIONS

The various policy alternatives examined in the study included: a base case, four key policy options, and six sensitivity analyses in which the effect of alternate assumptions was tested. A number of assumptions were made regarding the various levels of control and growth. The policy options were selected by the EPA to represent the full range of impacts and were not intended to represent real policy choices under active consideration. For these analyses, an attempt was made to make the evaluations as realistic as possible. For all policy options examined, offsets were assumed to be required and obtained during the period 1977 through 1979 as required by the Act.[1] Thus, for the "no-growth" policies, growth was assumed to be curtailed after 1979.

For the base case and each of the four policy options, a control technology level was assigned to each of the emission source categories (Table I-1). Major sources were separated into three separate groups: existing, new, and replacement. Mobile sources were addressed separately and included all road vehicles (such as cars, trucks, motorcycles, and buses) and other mobile sources (such as off-road vehicles, airplanes, ships, boats, and rail locomotives). Minor point and area sources were aggregated into the remaining source category. The control levels that were assigned to the various point and area source categories for each of the policy options included pre-1979 SIP control levels,[2] reasonably available control technology (RACT), and lowest achievable emission rate (LAER) as defined earlier (RACT-2 for area sources). The three levels of controls assigned to mobile sources included

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[1] The interpretative ruling for the offset policy was issued on December 21, 1976.

[2] Control technology permitted under the pre-1979 SIP, much of it more stringent than required.

TABLE I-1

CONTROL TECHNOLOGY ASSUMPTIONS USED FOR POLICY ANALYSES

	EMISSION SOURCE CATEGORY				
	MAJOR				
FUTURE SCENARIO	EXISTING	REPLACEMENTS[1]	NEW	MOBILE	MINOR/ AREA
I: Current SIP with Major Source Construction	SIP	LAER	LAER	FMVCP	SIP
II: RACT SIP with Major Source Construction	RACT	LAER[1]	LAER	FMVCP Strong I/M	RACT
III: RACT SIP with Offsets for Major Source Construction	RACT[3]	LAER	LAER	FMVCP Strong I/M	RACT[3]
IV: RACT SIP with No Major Source Construction after 1979	RACT	LAER[1]	N/A	FMVCP Strong I/M	RACT
V: LAER Replacement with No Major Source Construction after 1979[3]	LAER	LAER	N/A	FMVCP Strong I/M 20% TCP[4]	RACT-2

[1] A sensitivity analysis was also performed to indicate the effect that replacement of process equipment (and air pollution control systems) would have on emissions. For the basic analysis it was assumed that equipment replacements would not change air pollution control devices. Thus if RACT controls were already installed, new process equipment would not change the RACT level emissions from those sources. An analysis was also performed assuming replacement at RACT levels. This might occur (1) if replacement rates are greatly overestimated, (2) if replacement rates are significantly reduced in response to the policy options, or (3) if an alternative policy were applicable with respect to major source modifications.

[2] This scenario assumed that all existing sources were controlled to the maximum possible levels.

[3] In order to provide offsets, it was assumed that, as needed, these source categories can be further reduced beyond the RACT SIP. Existing major sources would reduce to LAER and Area/Minor sources would reduce to RACT-2.

[4] A 20% Transportation Control Plan assumed a 20% decrease in vehicle miles traveled and a corresponding 20% decrease in emissions.

the Federal Motor Vehicle Control Program (FMVCP) as scheduled under the Clean Air Act Amendments of 1977, a "strong" inspection and maintenance (I/M) program (defined by formal training of mechanics repairing vehicles and a 30% stringengy factor) and a 20% transportation control plan (a 20% reduction in vehicle miles traveled).

The base case, the four policy options, and the sensitivity scenarios are defined in more detail in the ensuing discussion.

I: Pre-1979 SIP with Major Source Construction

A base case analysis was first performed to illustrate the potential impacts if the pre-1979 SIP were not revised and major source construction took place using LAER controls. The following assumptions were made for the base case analysis for each of the source categories:

- Major New Stationary Sources - Growth was projected with LAER controls and no offsets were required after 1979.
- Major Existing Stationary Sources - Production was limited to 1976 levels and the pre-1979 SIP emission regulations[1] were applied to this source category.
- Minor and Area Stationary Sources - Growth was projected to continue with the pre-1979 SIP emission regulations.
- Mobile Sources - Growth was projected to continue with controls from the current FMVCP. No transportation control plans or I/M programs were assumed to exist.

II: RACT SIP with Major Source Construction

This policy option required all existing sources to be regulated at RACT levels. The RACT controls were phased in according to the initial EPA guideline schedules for issuance of control technology guidelines.[2] All major new source construction was regulated to insure LAER controls. No offsets were required after 1979. The following assumptions were made for each of the source categories.

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[1] Control technology permitted under the pre-1979 SIP, much of it more stringent than required.

[2] Walsh, Robert T., Release of Guidelines for Sources of Volatile Organic Compounds, November 22, 1977.

- Major New Stationary Sources - Growth was projected with LAER controls and no offsets were required after 1979.
- Major Existing Stationary Sources - Production was limited to 1976 levels and sources were retrofitted with RACT level controls.
- Minor and Area Stationary Sources - Growth was projected to continue with RACT level controls.
- Mobile Sources - Growth was projected to continue with controls from the current FMVCP and a strong I/M program (one that has formal training of mechanics repairing vehicles).

III: RACT SIP with Offsets for Major Source Construction

This policy option assumed that all existing sources were required to meet RACT controls through SIP revision regulations. All major new source construction met LAER controls and obtained offsetting emission reductions. The available pool of offsets included emission reductions from existing sources to RACT levels only until the promulgation of a revised SIP. Later, existing sources were assumed to be controlled to the LAER level, thus providing additional offsets. That is, sources were assumed to reduce emissions from pre-1979 to RACT over the next two years and then further reduce emissions to LAER beginning in 1981. Given the expense of retrofitting twice (from pre-1979 SIP to RACT and then RACT to LAER), this assumption is unlikely. For simplicity of analysis, it was assumed that the offset pool was fully tradeable and that such emission reductions could be carried over until needed. The following assumptions were made for each of the source categories:

- Major New Stationary Sources - Growth was projected with LAER controls and offsets were required from 1977 to 1990.
- Major Existing Stationary Sources - Production was limited to 1976 levels and sources were retrofitted first with RACT level controls and later with LAER controls.
- Minor and Area Stationary Sources - Growth was projected with RACT level controls and later with RACT-2 level controls for additional offsets.
- Mobile Sources - Growth was projected with controls from the current FMVCP and a strong I/M program (one that has formal training of mechanics repairing vehicles).

IV: RACT SIP with No Major Source Construction after 1979

This policy option attempted to demonstrate the effect of curtailing all major source construction and controlling existing sources with RACT. Although area, minor, and mobile sources were permitted to maintain the projected growth rates, emissions were expected to decrease because of better controls on existing sources and turnover to less polluting vehicles. The following assumptions were made for each of the source categories:

- Major New Stationary Sources - No major source construction.
- Major Existing Stationary Sources - Production was limited to 1976 levels and sources were retrofitted with RACT level controls.
- Minor and Area Stationary Sources - Growth was projected with RACT level controls.
- Mobile Sources - Growth was projected with controls from the current FMVCP and a strong I/M program (one that has formal training of mechanics repairing vehicles).

V: LAER Replacement with No Major Source Construction after 1979

This policy option was hypothetical. It assumed that all existing sources were replaced by 1990 with new sources having the same production capacity, but using LAER control technology. No net growth of major source capacity was allowed. The following assumptions were made for each of the source categories:

- Major New Stationary Sources - No major new source construction.
- Major Existing Stationary Sources - Production was limited to 1976 levels and sources were retrofitted with LAER level controls.
- Minor and Area Stationary Sources - Growth was projected with RACT-2 level controls (see Appendix C for definition).
- Mobile Sources - Growth was projected with controls from the current FMVCP, a strong I/M program, and 20% reduction in vehicle miles traveled.

SENSITIVITY ANALYSES

Sensitivity analyses were conducted to determine the impact on subsequent findings and conclusions of alternate assumptions. These included:

1. The accuracy of the emission inventory base;
2. The reliability of the ozone design value;
3. The growth rates of major new stationary sources;

4. The timing of growth;
5. The control technology assumptions; and
6. The selected oxidant standard (0.08, 0.10, 0.12 ppm).

DESCRIPTION OF THE METHODOLOGY

Figure I-3 is a schematic diagram representing the study methodology. It defines qualitatively the relationship between emission levels, present and future, and the policy alternatives under study here. In addition, it depicts the role of growth factors and control technology definitions as values regulating the growth of emissions. In this study, two empirical models have been used to estimate the changes in hydrocarbons and oxidant levels. Figure I-3 depicts the way new emission levels were determined in the study and not the way real world emission levels are actually reached. The validity of the study, however, depends upon the realism of the assumptions made, especially on the key relationship of hydrocarbons and their role in forming ozone. Other factors such as growth rates and control technology definitions are all critical in demonstrating attainment of the present 0.12 ppm ozone standard. Sensitivity analyses, which consider alternate assumptions, test and extend the validity of this study.

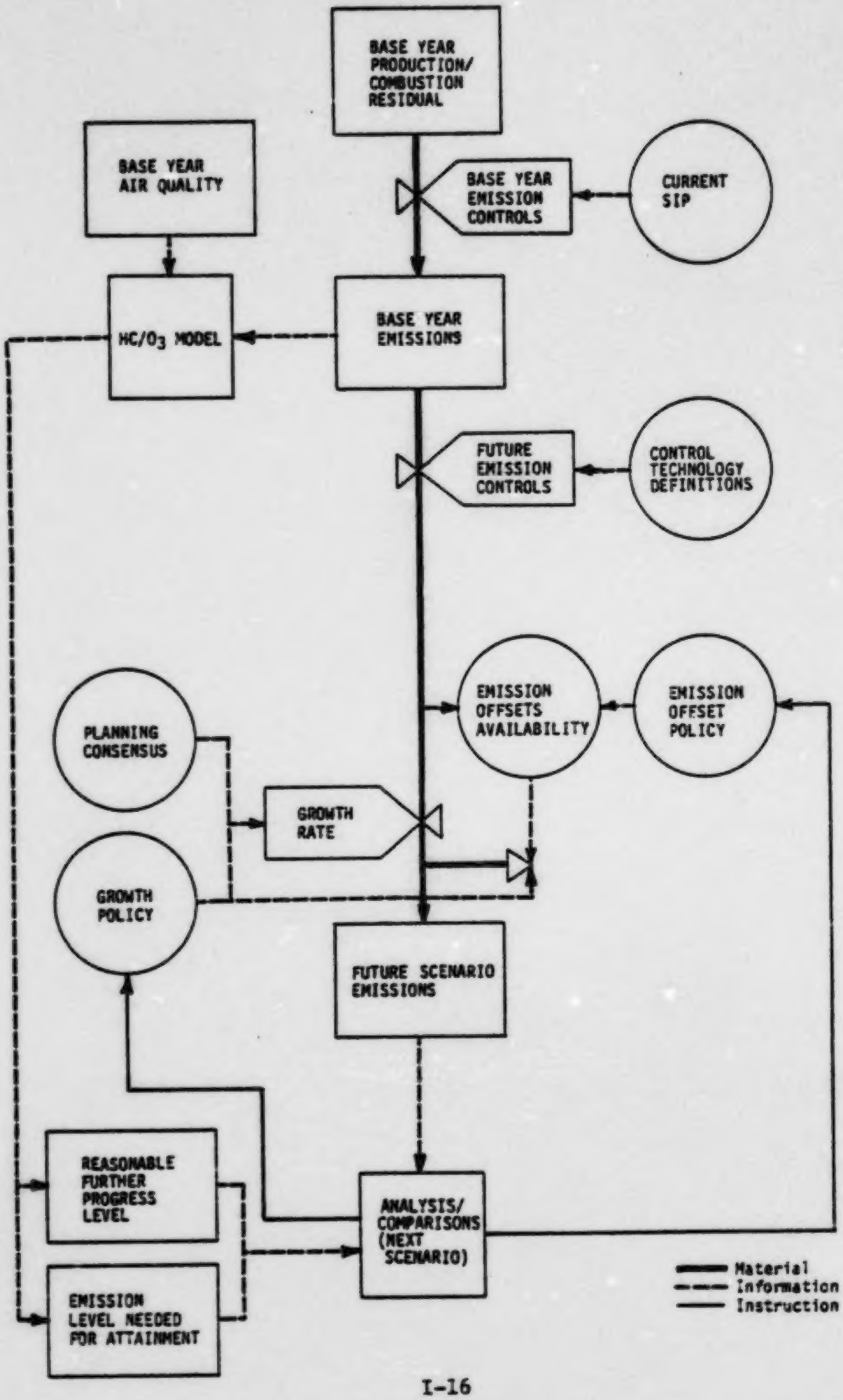
The base year used in this analysis was 1976. Three future years (1980, 1985, and 1990) were used for projections of emissions and air quality. The results also were analyzed for 1982 and 1987, two key attainment dates specified in the Clean Air Act Amendments of 1977, and for incremental results on an annual basis.

Base Year Inventory

Emission inventories were compiled for point sources, stationary area sources, and mobile sources. Point source inventories were obtained from the appropriate control agencies, reviewed, checked for consistency between production/combustion levels, uncontrolled emission facotrs, emission control efficiency, and emissions. Emissions which were judged to be entirely methane were deleted from the inventory. No attempt was made, however, to remove the methane fraction from complex emissions such as might come from a crude oil storage tank.

FIGURE I-3

STUDY METHODOLGY


BASE YEAR PRODUCTION/ COMBUSTION RESIDUAL
BASE YEAR AIR QUALITY
BASE YEAR EMISSION CONTROLS
CURRENT SIP
HC/O_3 MODEL
BASE YEAR EMISSIONS
FUTURE EMISSION CONTROLS
CONTROL TECHNOLOGY DEFINITIONS
EMISSION OFFSETS AVAILABILITY
EMISSION OFFSET POLICY
PLANNING CONSENSUS
GROWTH RATE
GROWTH POLICY
FUTURE SCENARIO EMISSIONS
REASONABLE FURTHER PROGRESS LEVEL
EMISSION LEVEL NEEDED FOR ATTAINMENT
ANALYSIS/ COMPARISONS (NEXT SCENARIO)
Material
Information
Instruction

The point source inventory compiled had a variable reference year from 1973 to 1976. ES attempted to update the inventory to 1976 by circulating the point source data to the control agencies and industrial contacts to confirm the currency of the operational data. Upon completion of this review, the compilation was considered the base year point source emission inventory.

An area source emission inventory had been developed for this region by GCA Corporation[1] for a 1974 base year. This was reviewed, validated or modified as necessary, and updated to base year 1976.

Mobile sources had been included in the GCA area source inventory and were treated similarly. Extensive revision was required only to the estimated emissions for highway vehicles. For this category VMT estimates were obtained from transportation planners for freeway and off-freeway road classes. These were applied to emission factors appropriate to the 1976 base year and travel characteristics provided by the same transportation planners. the composite emission factors were calculated by EPA's mobile source emission factor program, MOBILE 1.

The emission inventories prepared for the base year, and additional details of the compilation methodology, are presented in Appendix E.

Future Scenario Controls

Assumptions were made as to the level of control that could be applied to existing and new sources in order to fix the reduction of hydrocarbon emissions that could be achieved by increased control. These assumptions specified RACT and LAER level controls for point sources by the National Emissions Data System (NEDS) Source Classification Code (SCC) by assigning either a controlled emission factor or a control efficiency to the source for each level of control. These assignments were based on data from several general references, from other EPA contractors, and from discussion with EPA's Office of Air Quality Planning and Standards (OAQPS). A considerable effort was made to collect all of the limited data available. Still, these control technology definitions were not intended to reflect actual standards that could be required of specific sources by state regulations. Nor was any attempt made to forecast how control technology might improve with time.

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[1] Emission Inventory and Sulfur Dioxide Alternatives for the Metropolitan Philadelphia Region, Final Report, Contract #68-02-1376, Task Order No. 24 (U. S. EPA, Region III), August 1977, GCA/Technolgy Division, Bedford, Massachusetts.

Area sources, stationary and mobile, were also considered, though they are not (with the exception of highway vehicles) traditionally controlled sources. Again, assumptions were made as to the level of control which would constitute RACT and RACT-2 for area sources. Again, controlled emission factors or control efficiencies were specified. In the case of highway vehicles, the FMVCP's emission reductions were considered to define actual emissions in any future year; RACT controls were considered to be a strong inspection maintenance program (I/M) which implies 30% stringency and mechanics training; and RACT-2 controls required a 20% transportation control plan (a 20% reduction in vehicle miles traveled) in addition to the strong I/M.

These control technology definitions are discussed in greater detail in Appendix C. The list of emission factors/control efficiencies by SCC is also presented there.

Future Scenario Growth

Estimates of growth rates for major new industrial sources were obtained from a number of local planning agencies. Industrial growth in the Philadelphia region was allocated to the metropolitan area based upon the share of industrial production in the AQCR. The recommended EPA methodology for calculating replacement rates was used which is based upon simplifying assumptions and appeared to produce rapid turnover rates. For this study, analyses were made assuming (1) no replacement and (2) using the rapid replacement rates calculated by the EPA methodology.

Figure I-3 shows the growth rate to be set by "planning consensus". Actually, a considerable effort was expended to obtain plant-specific, even process-specific, growth projections with little success. A wide range of estimates was obtained when individuals from industry were solicited for the outlook in their own SCC. Projections for point sources were made by selecting a mid-range value and the extremes were considered in sensitivity analyses. Growth projections for area sources were mainly guided by DVRPC Projections[1] and standard statistical projections of governmental agencies.

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[1] Year 2000 Regional Development Guide Data Bank for Transportation Planning.

Further details on growth factors, including a listing of the factors actually used in the study, are presented in Appendix D. Projected emissions based on these growth factors are given in Appendix E.

Policy Alternatives

The policy alternatives selected by EPA represented a broad range of options available to the states to attain air quality and manage new emissions growth effectively. Some options required only RACT controls on existing sources and LAER on new sources while other options required the tightest possible controls on all sources. In one policy option, continuation of the EPA offset policy was examined, while in another, the effect of not permitting new major source construction was considered. Each policy option resulted in different emission levels because of the different control levels set, the need to offset emissions or not, and the amount of growth being considered. Each of these conditions was preset for each scenario as specified earlier.

As of November 1977, the EPA had issued a schedule for issuance, adoption, and implementatin of guidelines for control of sources of volatile organic compounds. The schedule is reproduced in Appendix C. For this study, it was assumed that the states concerned would adopt this schedule, issue SIP revisions for specific sources, and require compliance according to this schedule. This affects the availability of ACTUAL to RACT offsetting emissions because once the reduction is required by the SIP revision the source cannot be used to offset new emissions. More importantly, however, is the delay which has been experienced in the issuance of Control Technique Guidelines (CTG) since completion of this study. The EPA has revised by six months the deadlines for submittal of the RACT regulations for the second set of CTG's. The SIP's should now provide for the adoption and submittal of additional legally enforceable regulations by July 1, 1980 for the source categories contained in this second set. Moreover, delays have developed regarding the remaining CTG's because of the time required for the regulatory adoption process. These delays were anticipated and are addressed in a sensitivity analysis.

Future Scenario Emissions

Emission control factors and growth factors were applied to base year emissions according to the dictates of the policy alternatives of the future scenario under study. The methodology for applying emission control factors to point source emissions is presented in Appendix B. An IBM 370/158 computer was utilized for computational assistance and data processing to the degree possible. However, some hand processing of point source data obtained late and of area and mobile source data was necessary. The new emission level, reduced by any offsetting emission reductions used, constituted the future scenario emissions in any year.

The emissions from 1979 to 1982 and the level reached by 1987 were focal points of the study. The comparison of emission levels at these times with the emission levels needed to demonstrate reasonable further progress and and attainment by 1987 was the primary impact analysis of each future scenario (economic and social aspects are considered in other companion studies.)

ASSUMPTIONS AND LIMITATIONS

The following paragraphs contain a listing of some of the basic assumptions underlying the analysis which tend to limit the validity of the results, some of the technical difficulties encountered, and the means used to overcome these difficulties. Finally, a list of CAVEATS is presented.

Limiting Assumptions

1. Underlying the entire study is the assumption that hydrocarbon emissions anywhere in the AQCR contribute equally to ozone levels. That is, there is no source-receptor relationship. In fact, the spatial distribution of the emissions determines, for given meteorology, the distribution of hydrocarbon concentration. This should result in a horizontal field with local ozone maxima and minima, rather than a uniformly high concentration as assumed.

2. A related assumption considers all nonmethane hydrocarbons to be equal contributors to ozone production. Reactivity surely plays some role here even though it is poorly understood. Furthermore, no other contaminant is considered to contribute to or inhibite ozone production, except inasmuch as the EKMA model shows NO_x levels affect the hydrocarbon-ozone interaction.

3. Emissions are rarely projected directly and so projection of employment, earnings, and activity levels such as production were used to provide surrogate parameters for emissions growth. It was assumed that such factors

are in direct proportion to emissions. In some instances this assumption is sound, as in the case of dry cleaning emissions being proportional to population; in other cases it is not sound, as in the case of employment level being proportional to emissions in a chemical manufacturing process.

4. It was assumed that growth demand would not be affected by the policy alternatives considered. That is, whenever a policy allowed major source growth it was assumed that, no matter what control or offset conditions were stipulated, the growth would take place. Furthermore, minor source and area source growth took place at the same rate in each future scenario. In fact, the control policies would change the economic factors which affect investment decisions, equipment retirement decisions, and other growth decisions.

5. The assumption was made that RACT and LAER controls could be retrofitted on any existing source and achieve the same emissions control level as on new sources. In fact, new plant technology may involve a process modification or other hardware changes that would be difficult or impossible to install at an existing plant. Moreover, existing equipment process design on plants may limit options for installing the RACT controls assumed here. Costs were not taken into account.

6. The assumptions that offsets were available in exactly the amount required and at the time required is unrealistic. For the purposes of the study, it was assumed that the pool of all possible emission reductions was freely accessible to new growth. Any residual reduction was available for future use unless the pool was eliminated by a SIP revision. Because processes have basic production units with a modular size which have both intra- and inter-industry variation, these assumptions tended to overestimate available offsets.

Technical Difficulties

1. Where available, existing inventories reported hydrocarbon, not non-methane hydrocarbon (NMHC) emissions. Because of the very low reactivity of methane, it is EPA policy to eliminate methane from the inventory. The point source processes were reviewed to determine whether the effluent was primarily methane or not. For example, natural gas combustion products were eliminated when they alone made up the effluent. Mixtures were not reduced by an estimated methane fraction, however.

2. There was no reliable hydrocarbon point source inventory available for the four exterior Pennsylvania counties: Bucks, Chester, Delaware, and Montgomery. A questionnaire program initiated earlier by DER was being validated and encoded at the outset of the study. Pennsylvania Emission Data System (PEDS) code forms were supplied as they were prepared and, after review and editing, the data were entered into the master file in NEDS format. However, some data were received too late and had to be hand-processed for inclusion in the study. Hand-processing is understood to be more error prone and less well documented. In addition, data from two plants - the Goodrich and Firestone Rubber Manufacturing Plants - were received too late to be considered at all. However, this amounted to only several hundred tpy of hydrocarbon emissions, less than 0.25% of the point source inventory, that was not included.

3. Reported petroleum storage emissions loss in several instances was inconsistent when the material stored was considered. Storage of No. 6 residual oil or slop oil will be accompanied by only small loss because of the low vapor pressure. Review and adjustment was made where indicated. When high vapor pressure products were stored, overestimation of the evaporation loss was evident. This is because emission estimates for fixed and floating roof tanks based on the API Method published in AP-42[1] have been shown to be too high by a factor of 2 to 3 in an independent study by ES.[2] Emissions from these sources were reduced by 60% if they had fixed roofs, 50% if they had floating roofs.

Caveats

1. The Philadelphia AQCR was studied to assist in formulating national policy. Nothing contained in this report is intended to reflect EPA's judgment of policy needs for the Philadelphia region.

2. Assumptions made in control technology definitions were ad hoc assumptions necessary for the study to proceed. They do not represent EPA guidelines for any industry or process nor do they purport to be useful for any other purpose than this study.

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[1] Compilation of Air Pollutant Emission Factors, Supplement 7, U. S. EPA, OAWM, OAQPS, Research Triangle Park, N. C.

[2] Hydrocarbon Emissions from Floating Roof Petroleum Tanks, by Engineering-Science, Inc., Arcadia, California, prepared for Western Gas and Oil Association, Los Angeles, California 91107, January 1977.

CHAPTER II

SUMMARY AND CONCLUSIONS

An analysis was made of several policy options for the Philadelphia AQCR to determine the best method for handling new source growth in this nonattainment area. Measured ozone air quality in the area was almost twice the standard. The current EPA methodology for attaining the ozone standard calls for the reduction of nonmethane hydrocarbon (NMHC) emissions. The ozone design value established by a consensus of the control agencies affected was 0.22 ppm which establishes a required nonmethane hydrocarbon emission reduction of 50% to attain the 0.12 ppm standard if the modified rollback method of estimation is used. Using the EKMA procedure, with and without consideration for transport, reductions of 69 and 66% are necessary, respectively. It is recognized that alternate models might establish different emission reduction goals.

A NMHC emission inventory was compiled for major point, mobile, stationary area, and minor point sources. Growth expectations were established in consultation with local planning agencies and industrialists. In order to achieve reductions in NMHC, assumptions were made on the level of control that could be applied to major point, mobile, stationary area, and minor point sources. The RACT and LAER control technology definitions used in this study were developed from literature searches and reviewed by EPA's ESED. The analysis proceeded by applying growth and control increments (decrements) to the appropriate emission category as required over the period by the various policy options.

After establishing the base or "no action" case, the study considered a RACT SIP, a RACT SIP with 1:1 and 3:1 offsets, and two no-growth scenarios. The study period was 1976 through 1990 focusing on the question of reasonable further progress (RFP) in 1982 and attainment no later than 1987. The policies represent a broad range of options which could be available for control officials in meeting Clean Air Act requirements.

REASONABLE FURTHER PROGRESS

1. All options were easily below the emission level required to show reasonable further progress by either (modified rollback or EKMA) estimation method by December 31, 1982.

ATTAINMENT OF THE STANDARD

1. Concerning attainment by December 31, 1987, all RACT options achieved greater reduction than required by the modified rollback and the EKMA (without consideration of transport) estimates. The RACT options achieved reductions approximately equivalent to those required by the EKMA (with consideration of transport) procedure.

2. The difference in reduction achieved from the offset and no growth scenarios, 69% for the RACT SIP and 71% for the most stringent no growth scenarios, was very small.

3. An emission offset policy in the Philadelphia AQCR does not appear to restrict growth since projected growth is small and there are many offsets available, even after RACT control levels are established. A 3:1 offset ratio was not very effective in reducing emissions during the period that the RACT SIP was being promulgated. An offset policy appears to have potential for the period after attainment is achieved.

4. Assuming the modified rollback and EKMA (without consideration of transport) calculated emission reductions needed to attain the standard, the results of the study were found to be quite insensitive to changes in the base year emission inventory, growth pulses or clustered in the early or late period, or improvements in control technology. However, assuming EKMA (with transport) emission reductions needed to attain, the results of the study were quite sensitive to changes in the aforementioned parameters because the emission level required was on the threshold of the policy option emission levels.

5. The results of the study are also quite dependent upon the ozone design value and the ozone standard promulgated. The highest ozone design value that could have been chosen from the data available places all options on the threshold of attainment by rollback and well above the level predicted by EKMA. The effect of the ozone standard is even greater. If the old 0.08 ppm standard would have been maintained, no policy options studied achieved the reduction required by the least conservative estimate technique (rollback, 73%). If the standard had been set at 0.10 ppm, all options except RACT SIP would have achieved the reduction required by the most conservative estimate (rollback, 61%).

6. If the level of emissions required to attain is really best represented by the EKMA estimate and that level will ultimately have to be reached, it appears that this might be achieved by what amounts to a RACT SIP: control of existing point sources at the RACT level; control of area sources at the RACT level; and control of mobile sources by the FMVCP and an inspection/maintenance program.

CHAPTER III

DATA INPUTS USED FOR ANALYSES

This chapter provides a summary of the data used to conduct the policy analyses for this study. The data were comprised of four basic elements:

- Emission inventories;
- Control technology definitions;
- Growth projections; and
- Replacement rates of production facilities.

The appendices of this report contain detailed information concerning the methodologies and sources used in compiling the data base.

The purpose of this chapter is to define the resulting data summaries, identify how they were used in the analyses, and focus on the key elements affecting the policy analyses. Each of the above data bases is discussed separately. Emission inventories are discussed in two parts. The base year emission inventory reflects the data that were used to define present conditions. Lastly, a SIP allowable discussion addresses the baseline emission inventory used to calculate offsets.

BASE YEAR EMISSION INVENTORIES

For this analysis, the nonmethane hydrocarbon (NMHC) emission inventory was divided into three categories which are used throughout this report:

- Major/minor point sources;
- Mobile sources; and
- Stationary area sources.

Appendix E includes specific methodology used to tabulate NMHC emissions for the Philadelphia AQCR. In general, the major and minor point source emission inventories were based on data supplied by Philadelphia Air Management Services (AMS), Delaware Department of Natural Resources and Environmental Control (DNREC), New Jersey Department of Environmental Protection (DEP), and EPA Region III, plus data generated by Engineering-Science (ES) from questionnaires received by Pennsylvania Department of Environmental Resources (DER). The inventory of emissions from highway vehicles was prepared by EPA and the off-highway vehicle emissions inventory was prepared by ES based on a 1974 GCA inventory. For a complete definition of each source category, refer to Appendix E.

Major/Minor Point Sources

A summary of the NMHC point source emission inventory used in this study appears in Table III-1 and is defined in terms of twelve general industrial categories. The inventory reflects emissions in the base year 1976. Fugitive hydrocarbon emissions for the larger major point sources are included in the emission information presented. The 1976 actual emissions are also presented as if these were controlled to RACT or LAER levels (see Appendix C for RACT and LAER definitions). A later discussion compares the two data bases. In addition to the 1976 inventory, Table III-1 also tabulates additional NMHC emissions in 1990 assuming all new emissions were controlled to LAER levels, with offsets required and with offsets not required.

The major and minor point source emissions appearing in the baseline inventory total 167,569 tpy or approximately 36% of the entire inventory. A recent court ruling on June 18, 1979 (Alabama Power Company vs. Costle, 13 ERC 1225) defined major sources as those emitting greater than 100 tpy of potential controlled emissions. However, for the purpose of this study, major point source emissions were defined as those greater than 100 tpy of potential uncontrolled emissions in the base year 1976. These totaled 152,001 tpy for the entire AQCR or approximately 33% of the entire inventory. Approximately 29% of these major point source emissions originated from petroleum product storage, 24% from petroleum refining, 26% from surface coating, and 7% from chemical manufacturing. Figure III-1 illustrates the percentage of emissions of the categories comprising the point sources.

Minor point source emissions were defined as those less than 100 tpy of potential emissions in the base year 1976. These totaled 15,568 tpy for the entire AQCR or approximately 3% of the entire inventory. These emissions were estimated to increase by approximately the same amount as the stationary area source category which is described later; however, because the 1976 actual emissions were relatively small, this category is projected to remain relatively insignificant.

Mobile Sources

Mobile sources include highway vehicles and off-highway vehicles such as construction, farm vehicles, ships, pleasure boats, aircraft, and railroads. Highway emissions, as discussed in Appendix E, were computed by EPA's Office

TABLE III-1

A COMPARISON OF 1976 ACTUAL, RACT, LAER, AND PROJECTED ADDITIONAL POINT EMISSIONS BY 1990 FOR NONMETHANE HYDROCARBONS

	1976 EMISSIONS (TPY)			ADDITIONAL POINT EMISSIONS BY 1990	
INDUSTRY/PRODUCT/PROCESS	ACTUAL	RACT	LAER	OFFSETS REQUIRED(1)	OFFSETS NOT REQUIRED(2)
BOILERS					
Electric Utility	1,051	1,051	7	0	158
Industrial	1,460	945	605	0	198
Commercial/Industitutional	134	134	33	0	60
STATIONARY INTERNAL COMBUSTION	326	326	10	0	2
CHEMICAL MANUFACTURING					
Chlorine	328	328	328	97	2
Cleaning Chemicals	193	193	193	58	0
Paint Manufacturing	218	15	15	0	2
Varnish Manufacturing	164	9	9	0	2
Plastics	1,230	452	330	0	95
Phthalic Anydride	700	70	7	0	2
Printing Ink	80	8	8	0	2
Synthetic Rubber	1,020	117	108	0	33
Adhesives	482	123	12	0	12
Sulfonic Acid	1,270	15	15	356	25
All Other Chemical Manufacturing	6,160	6,160	6,160	743	379

TABLE III-1 (cont)

A COMPARISON OF 1976 ACTUAL, RACT, LAER, AND PROJECTED ADDITIONAL POINT EMISSIONS BY 1990 FOR NONMETHANE HYDROCARBONS

INDUSTRY/PRODUCT/PROCESS	1976 EMISSIONS (TPY)			ADDITIONAL POINT EMISSIONS BY 1990	
	ACTUAL	RACT	LAER	OFFSETS REQUIRED(1)	OFFSETS NOT REQUIRED(2)
OTHER MANUFACTURING	310	310	310	0	44
IRON & STEEL PRODUCTION					
Coke Met. By-Products	3,630	725	306	0	44
Iron Production	25	25	25	0	7
PETROLEUM REFINING					
Process Heater	530	18	17	0	7
Fluid Crackers	4,499	112	90	0	13
Moveable Bed Catalytic Cracker	4	4	4	0	1
Blow-Down System	2,025	34	34	0	10
Process Drains	14,279	1,090	1,090	122	41
Vacuum Jets	1,899	1	1	0	0
Cooling Towers	862	28	28	0	13
Miscellaneous Fugitive Emissions (Flanges, Valves, Seals, Etc.)	15,056	655	559	0	133
Flares	283	283	283	0	42
Asphalt Oxidizer	8	0	0	0	0
All Others	657	657	657	77	59

TABLE III-1 (cont)

A COMPARISON OF 1976 ACTUAL, RACT, LAER, AND PROJECTED ADDITIONAL POINT EMISSIONS BY 1990 FOR NONMETHANE HYDROCARBONS

	1976 EMISSIONS (TPY)			ADDITIONAL POINT EMISSIONS BY 1990	
INDUSTRY/PRODUCT/PROCESS	ACTUAL	RACT	LAER	OFFSETS REQUIRED(1)	OFFSETS NOT REQUIRED(2)
CLEANING/SOLVENT					
Dry Cleaning[b]	117	10	8	0	4
Degreasing	929	494	274	0	118
SURFACE COATING					
Paper & Allied Products	15,909	2,865	1,103	0	250
Misc. Plastic Products	4,495	360	46	0	12
Fabricated Metals	8,234	6,034	1,408	169	51
Transportation Equipment	8,739	1,571	405	105	136
All Others	6,296	2,426	1,238	124	189
PETROLEUM PRODUCT STORAGE					
Fixed Roof	45,520	4,530	2,768	229	201
Floating Roof	2,459	2,120	1,822	0	340
Variable Vapor Space	8	8	2	0	0
All Others	514	103	13	0	165
PRINTING PRESS	7,897	1,398	900	0	213

TABLE III-1 (cont)

A COMPARISON OF 1976 ACTUAL, RACT, LAER, AND PROJECTED ADDITIONAL POINT EMISSIONS BY 1990 FOR NONMETHANE HYDROCARBONS

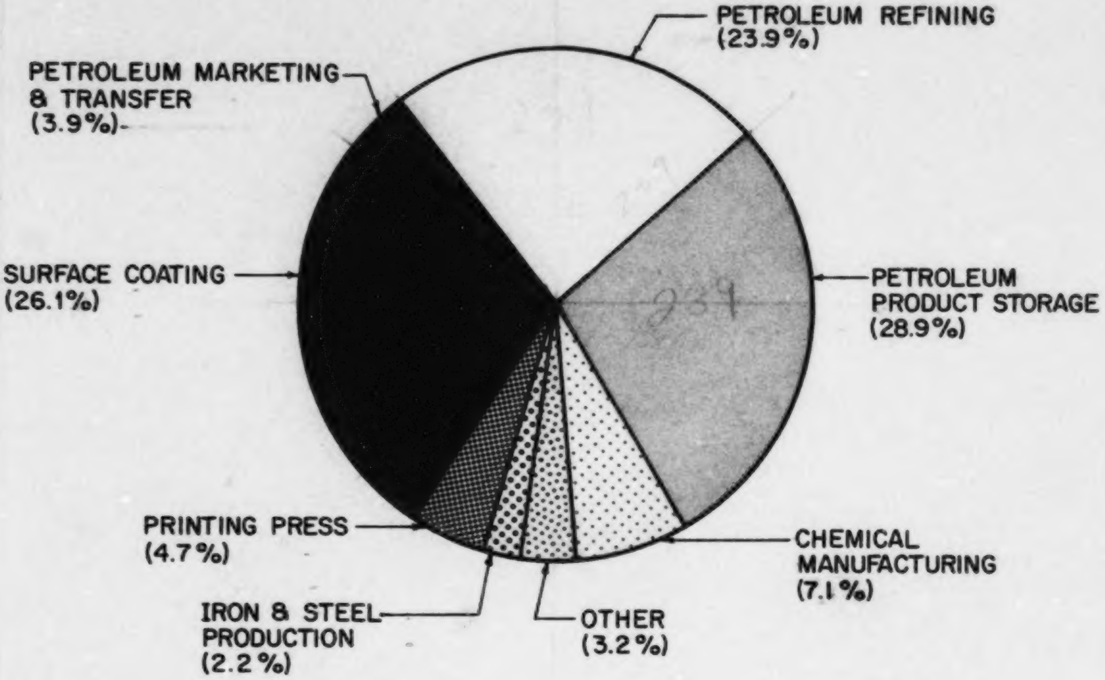
	1976 EMISSIONS (TPY)		ADDITIONAL POINT EMISSIONS BY 1990		
INDUSTRY/PRODUCT/PROCESS	ACTUAL	RACT	LAER	OFFSETS REQUIRED(1)	OFFSETS NOT REQUIRED(2)
PETROLEUM MARKETING & TRANSFER					
Tank Cars, Trucks	285	91	33	0	9
Marine Vessels	6,267	328	63	0	9
INCINERATION					
Government	917	492	0	0	98
Industrial	100	24	24	0	16
TOTALS	167,569	36,742	21,351	2,080	3,197

(1) Increments/growth ≥ 50 tpy of major sources, for certain policy options.

(2) Increments/growth < 50 tpy of major source and minor source growth.

FIGURE III-1

INDUSTRIAL COMPONENTS OF THE 1976 BASE YEAR POINT SOURCE EMISSION INVENTORY FOR NON-METHANE HYDROCARBONS



CHEMICAL MANUFACTURING	11,845	tons/yr.
IRON & STEEL PRODUCTION	3,655	tons/yr.
PETROLEUM REFINING	40,102	tons/yr.
SURFACE COATING	43,673	tons/yr.
PETROLEUM PRODUCT STORAGE	48,501	tons/yr.
PRINTING PRESS	7,897	tons/yr.
PETROLEUM MARKETING & TRANSFER	6,552	tons/yr.
OTHER	5,344	tons/yr.
TOTAL	167,569	tons/yr.

of Transportation and Land Use Planning (OTLUP) using the MOBILE I emission factor program. Hot and cold start factors used in the program reflected national average figures. For the policy analysis, road vehicle emissions were calculated using vehicle miles traveled (VMT) data from the Delaware Valley Regional Planning Commission (DVRPC) and the input parameters listed in Table III-2. These input parameters resulted in the following emission factors.

	Factor (GMS/VMT)	
	1977	1987
Freeway	5.84	1.28
Non-Freeway	9.98	2.58

Area source emissions from the off-highway sector had been calculated by standard EPA methods as an update of recent (1974) area source inventories prepared for EPA by GCA. The estimation techniques are described in Appendix E. As depicted in Table III-3, the NMHC discharged from this category was 252,410 tpy or 54% of the total 1976 NMHC inventory. Highway vehicles contributed 229,672 tpy (91%) of this source category's emissions while off-highway vehicles contributed only 22,738 tpy (9%).

Stationary Area Sources

Area sources are point sources too numerous and small to tabulate and include emissions from paving and solvent evaporation as well as from small point sources such as small home, commercial, and industrial combustion points, fuel handling, and dry cleaning. The methodology for estimating the 1976 NMHC emissions from these sources is described in Appendix E. Total discharges from this category were 46,534 tpy in 1976. This represents approximately 10% of the total 1976 NMHC emission inventory as shown in Figure III-2. As can be seen in Table III-3, the greatest part of these emissions were discharged from fuel handling, solvent evaporation, and dry cleaning, which are small sources not listed in the point source emissions inventory.

Total Emissions

The NMHC emissions listed in Tables III-1 and III-3 for 1976 are summarized in Figure III-2. The annual emissions from all sources amounted to 466,513 tpy in 1976. Of this, more than half (54%) is attributable to mobile sources and 91% of that is due to highway vehicle emissions (Table III-3). Area sources comprise 10% of the emissions. Point sources contribute about 36% of the total

TABLE III-2

INPUT PARAMETERS TO MOBILE 1
EMISSION FACTOR CALCULATIONS[A]

Average Temperature (°F)	55
Average Traffic Speeds (mph)	
Freeway	35
Non-Freeway	15
Hot/Cold Start Factors (%)[B]	
PCCO	21
PCHS	27
PCCC	21

Freeway/Non-Freeway VMT Split

Year	Freeway	Non-Freeway
1977	0.239	0.761
1982	0.240	0.760
1987	0.243	0.757

Stringency Factor of Inspection Standards (%)	
Weak Program	15
Strong Program	30

[A] All other parameters are national averages.

[B] Reflect national average factors.

TABLE III-3

SUMMARY OF MOBILE AND STATIONARY AREA, BASE YEAR EMISSIONS AND PROJECTED INCREMENTS WITH VARIOUS CONTROLS FOR NONMETHANE HYDROCARBONS

(tons/year)

CATEGORY	1976			ADDITIONAL EMISSIONS OVER 1976								
				1980			1985			1990		
	ACTUAL[1]	RACT	RACT-2[5]	UNC[2]	RACT	RACT-2[5]	UNC[2]	RACT	RACT-2[5]	UNC[2]	RACT	RACT-2[5]
Area Sources:												
Combustion	3,169	2,569	2,569	1,833	110	110	1,545	259	259	1,497	396	396
Fuel Handling	26,290	2,629	2,392	2,110	211	192	4,660	466	424	6,900	690	628
Solvent Evaporation	10,090	1,513	1,009	260	40	26	510	77	51	730	110	73
Dry Cleaning	5,735	860	574	115	18	11	310	47	31	475	72	47
Paving	1,250	0	0	-1,000	0	0	-1,030	0	0	-1,030	0	0
Sub-Total	46,534	7,571	6,544	3,318	379	339	5,995	849	765	8,572	1,268	1,144
Mobile Sources:[4]												
Highway Vehicles	229,672	229,672	229,672	-59,817[6]	-67,805[3]	-67,805[3]	-122,535[6]	-140,821[3]	-158,591[3]	-154,060	-176,880[3]	-187,438[3]
Off-Highway Veh.	22,738	22,738	22,738	1,331	1,331	1,331	3,314	3,314	3,314	- 4,813	- 4,813	- 4,813
Sub-Total	252,410	252,410	252,410	-58,486	-66,474	-66,474	-119,221	-137,507	-155,277	-158,873	-181,693	-192,251
Total	298,944	259,981	258,954	-55,168	-66,095	-66,135	-113,226	-136,658	-154,512	-150,301	-180,425	-191,107

[1] Actual emissions.

[2] No additional controls were assumed other than those which existed in the base year.

[3] Auto emissions were calculated using FMVCP emission limits, a strong auto inspection and maintenance program, and no transportation control plan.

[4] Mobile emissions for 1980, 1985, and 1990 showed decreases even though there was an increase in VMT of 26% between 1976 and 1990.

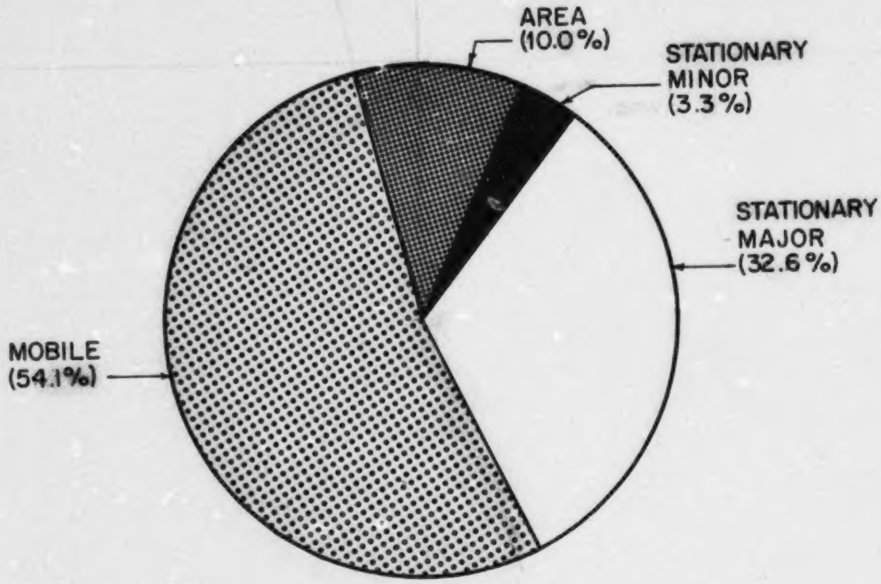
[5] RACT-2 includes a 20% reduction in VMT, fitting those minor point sources listed under area sources with more stringent controls, and tighter controls on area sources.

[6] Automobile emissions assuming only the FMVCP was in effect.

10

FIGURE III-2

1976 BASE YEAR EMISSION INVENTORY FOR NON METHANE HYDROCARBONS



STATIONARY POINT SOURCES		
MAJOR (≥100 tpy potential)	152,001	tons/yr.
MINOR (<100 tpy potential)	15,568	tons/yr.
STATIONARY AREA SOURCES	46,534	tons/yr.
MOBILE SOURCES	252,410	tons/yr.
TOTAL	466,513	tons/yr.

-issions about 91% of which is attributable to major sources. Despite the extensive control programs prior to 1976 for mobile and major point sources, the greatest opportunity to reduce emissions is still found in these two source categories.

SIP ALLOWABLE EMISSIONS

SIP allowable emission levels refer to the maximum permissible emissions for a given source or process category. The limits are usually specified in terms of pounds of emissions allowed for some level of production. For example, sulfur dioxide emissions are limited to 0.6 pounds per 10^6 BTU heat input. Regulatory agencies specify maximum permissible emission levels for both particulates and sulfur dioxide. However, for hydrocarbons a different approach has been used to specify the maximum emission level. Rather than establish specific quantities over some period of time according to production levels, most agencies specify the type of control system that must be used with each hydrocarbon source. For example, Pennsylvania, New Jersey, and Delaware regulations require that all storage tanks have floating roof tanks. Fixed roof tanks are required to have a vapor collection system. Both floating and fixed roof tanks existed in the study area in 1976 and their emissions were included in the point source inventory. The same is true with loading facilities where vapor recovery systems are required. For all jurisdictions, water separators are required for any process drains which contain oil. In the case of ethylene production plants, a flaring system is required that would incinerate the exhaust gases to a temperature of 1300°F for a period of 0.3 seconds. The estimates of emission rates from these types of processes have been developed by EPA. Specific emission factors apply to storage tanks which contain floating roofs. The same is true for water separators (API separators) and the other categories mentioned above. Thus, for these types of sources, the expected emissions will be identical to the SIP allowable emission levels.

Philadelphia County also has adopted the Bay area regulations as a model which specifies mass emission limits for hydrocarbon emissions for certain categories. One such category covered by this regulation involves surface coating. A comparison was made of the allowable emission levels for surface coating operations and the actual emission levels reported in Philadelphia

County. The 1976 actual emission levels were 1,924 tpy. The SIP allowable level for these same plants totaled 3,544 tpy. The actual levels were about 54% of the SIP allowable level. Other counties in the AQCR either had no specific regulations or required the use of a specific abatement system such as incineration. There are two other point source categories which are covered by specific mass emission limits in Philadelphia County. These include surface coating and degreasing operations and any printing press operations which use reactant solvents. A comparison of the actual and SIP allowable emissions for these two categories has not been completed. Specific information regarding the production rate as well as the hours of operation are necessary in order to make this comparison. These data were not normally available for sources in Philadelphia County for these two categories.

The purpose of this study was to examine the potential for reducing actual emissions through the adoption of various policy options. To accomplish this task, a good estimate of actual emissions was required. For most categories representing approximately 90% of total emissions, the SIP allowable and the actual emissions are identical; therefore, the SIP allowable level was used. However, in the case of certain emission categories, such as surface coating, degreasing, and printing press operations, the SIP allowable level overestimates the actual reported emissions. This was due to the type of regulation used for limiting hydrocarbon emissions from these sources. In these cases, actual reported emissions were assumed to be more indicative and were used in the analysis.

CONTROL TECHNOLOGY DEFINITIONS

RACT and LAER definitions are summarized in Appendix C for more than 200 different industrial processes. These definitions were applied to each stack/source in the inventory and then summed to determine emissions over the entire AQCR. If a source already had controls which were better than the RACT/LAER assumptions used in this analysis, no change in emissions was calculated. Thus, for this analysis, application of RACT or LAER controls could only reduce emissions.

There were no LAER definitions for many (23%) of the major sources for which emissions growth was anticipated. In these cases, the RACT factor was used for analytical purposes. In some instances, a RACT definition was not available either. When no RACT factor was available or where production or other information necessary to use the RACT factor was unavailable, emissions were still reduced for that process (using default values), but perhaps not by as much as would be assumed if specific information were available. Figure III-3 provides an indication of the percentage of base year (1976) point source emissions for which RACT/LAER control technology definitions were specified in Appendix C.

GROWTH IN EMISSIONS

Major/Minor Point Sources

Table III-1 shows the increase in NMHC emissions expected for each major point source category. Growth data were obtained from a number of different sources, including local and state planning agencies, other EPA contractors, and recently published articles in technical journals as explained in Appendix D. By knowing the production rates in the base year and the anticipated growth, growth in any future period could be predicted. The additional production was assumed to correspond proportionately to an increase in emissions. In this analysis, all new major source growth was assumed to use controls. This is consistent with the present policies in the AQCR which require Best Available Control Technology (BACT) on new sources. Additional emissions by 1990 from point sources are expected to be 2,080 tpy if offsets are required for new construction and 3,197 tpy if offsets are not required. This represents a growth in point source emissions of about 2% for the worst case.

Mobile Sources

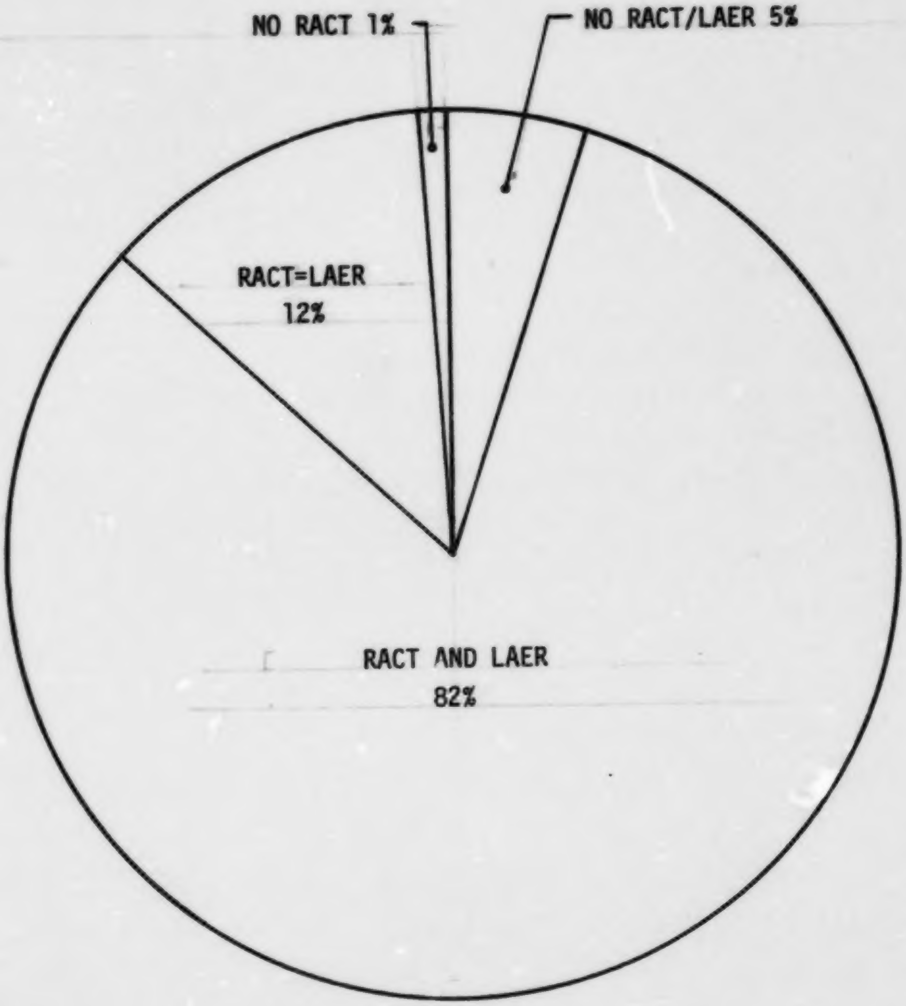
Table III-2 also summarizes the emissions reductions for mobile sources in 1980, 1985, and 1990. Although there is expected to be an increase in the vehicle miles traveled, mobile source emissions are expected to decrease substantially between 1975 and 1990 because of the Federal Motor Vehicle Control Program (FMVCP). The reduction in emissions which results from the FMVCP is far greater than the potential increase due to increased travel. In 1985, it was also assumed that aircraft emissions would begin decreasing (through the end of the study year 1990) because of better controls. This would result in an overall reduction of 158,873 tpy by 1990 even if there were no change in existing regulations. Application of

3019.70

FIGURE III-3

RACT/LAER COVERAGE[1]
PHILADELPHIA AQCR

270



[1] PERCENT OF TOTAL POINT SOURCE EMISSIONS COVERED BY CONTROL TECHNOLOGY DEFINITIONS.

more stringent regulation (RACT-2) could bring about a reduction of 192,251 tpy of NMHC by 1990.

Stationary Area Sources

Table III-2 also summarizes the additional NMHC emissions attributable to stationary area source growth for 1980, 1985, and 1990. If no changes were made to existing regulations, the NMHC emissions from stationary area sources might increase by 8,572 tpy in 1990. Application of RACT or RACT-2 to this category could limit the increase to 1,268 or 1,144 tpy by 1990, respectively.

AVAILABILITY OF OFFSETS

Table III-4, which shows changes in availability of offsets from existing point sources due to scheduled SIP revisions, was calculated from data presented in Appendix E and from considerations of when SIP revisions would be expected to affect each category. The dates on which SIP revisions are expected to be issued are listed in Table C-1, Appendix C.

These tables are used to estimate the probable total NMHC emissions in future years, as well as to estimate the offsets available to permit realization of compliance schedules.

GROWTH AND REPLACEMENT

Major Point Sources

Table III-1 shows the increase in hydrocarbon emissions expected in each major point source category according to whether or not offsetting emissions would be required. In all offset policy applications, it was assumed that major source growth, be it modification or new construction, would need offsets provided that the new emissions contribution was greater than 50 tpy actual emissions. These values are obtained by multiplying the actual, RACT, or LAER emissions from each source by a growth factor after first compiling the sources in major and minor categories as defined above. Growth factors were obtained from local and national sources as discussed in Appendix D. Those increments not requiring offsets are the increments of minor sources and those major source increments less than 50 tpy.

TABLE III-4

CHANGES IN AVAILABILITY OF OFFSETS FROM EXISTING (1976) POINT SOURCES DUE TO SCHEDULED SIP REVISIONS

INDUSTRY, PROCESS	DATES: SIP REVISION/ COMPLIANCE	RACT OFFSETS AVAILABLE ON JUNE 30				LAER OFFSETS AVAILABLE (1976)
		1976	1979	1980	1982	
EXTERNAL & INTERNAL COMBUSTION[1]	1979/1982	1,163	0	0	0	1,153
CHEMICAL MANUFACTURING	1980/1984	4,355	4,355	0	0	305
IRON AND STEEL PRODUCTION[1]	1979/1982	2,905	0	0	0	419
PETROLEUM REFINING						
Process Heaters & Fluid Crackers	1979/1982	4,899	0	0	0	23
All Other Processes	1980/1984	23,364[2]	23,364	0	0	96
CLEANING/SOLVENT						
Dry Cleaning	1980/1984	107	107	0	0	2
Degreasing	1979/1982	435	0	0	0	220
SURFACE COATING						
Paper & Allied Product	1979/1982	13,044	0	0	0	1,762
Misc. Plastic Products	1979/1982	4,135	0	0	0	314
Fabricated Metals	1979/1982	1,552	0	0	0	5,274
Transportation Equipment	1982/1986	7,168	7,168	7,168	0	1,166
All Others	1982/1986	3,873	3,873	3,873	0	1,188
PETROLEUM PRODUCT STORAGE	1979/1982	448[2]	0	0	0	2,156
PRINTING PRESS	1980/1984	6,499	6,499	0	0	498

TABLE III-4 (Continued)

CHANGES IN AVAILABILITY OF OFFSETS FROM EXISTING (1976) POINT SOURCES DUE TO SCHEDULED SIP REVISIONS

	DATES: SIP REVISION/ COMPLIANCE	RACT OFFSETS AVAILABLE ON JUNE 30				LAER OFFSETS AVAILABLE (1976)
		1976	1979	1980	1982	
PETROLEUM MARKETING & TRANSFER						
Tank Cars, Trucks	1979/1982	194	0	0	0	58
Marine Vessels	1980/1984	5,939	5,939	0	0	265
INCINERATION[1]	1979/1982	501	0	0	0	492
TOTAL		80,581	51,305[3]	11,041[4]	0[5]	15,391

NOTE: [1] These categories are not specifically scheduled for SIP revision; however, because control technology is readily available, they have been included here in the earliest SIP revision.

[2] Reduction due to compliance with present SIP is not available as an offset.

[3] When the SIP revision is promulgated in June 1979, as provided in the CTG Schedule (Table C-1), sources emitting 29,276 tpy above RACT will be required to reduce emissions to RACT levels by 1982; 23,138 tpy will be from major sources and 6,138 tpy will be from minor sources.

[4] When the SIP revisions of December 1979 and June 1980 are promulgated, as provided in the CTG Schedule (Table C-1), sources emitting 40,264 tpy above RACT will be required to reduce emissions to RACT levels by 1984; 38,617 tpy will be from major sources and 1,647 tpy will be from minor sources.

[5] When the SIP revision of December 1981 is promulgated, as provided in the CTG Schedule (Table C-1), sources emitting 11,041 tpy above RACT will be required to reduce emissions to RACT levels by 1986; all of them will be major sources.

All major source growth was assumed to require LAER technology; minor source increments were assumed to require RACT technology. The total growth of point source emissions in the 14-year study period was expected to be only 5,277 tpy (see Table III-1). This is a 3% increase, but it includes the effect of control technology improvement. Note that the projection method used avoids the projection of production. Also, with the assumption that all major source growth requires LAER, the need to consider expansion to capacity or new construction is avoided. This is of no consequence as long as there is no source/receptor relationship involved.

Replacement rates were calculated using the EPA Air Quality Maintenance Area (AQMA) guideline procedure which suggests that the useful life be set at twice the IRS depreciation period (see Appendix D). This leads to the following estimates for turnover in key industries:

- Chemical industry - 22 years
- Petroleum refining, storage, and marketing - 32 years
- Surface coating - 32 years

Since replacement must be at LAER for major source, a continuous reduction in emissions will result from this category.

The study covers the years 1976 to 1990. It was assumed that LAER replacements started in 1977. Thus, one would normally expect 64% (14/22) of the chemical and 44% (14/32) of the surface coating and petroleum refining, storage, and marketing emissions to be replaced with LAER in the 14-year period. This would result in a net reduction of 58,934 tpy to be realized from LAER replacement by 1990.

Mobile and Stationary Area Sources

Area source emissions were linked through the activity which produces the emissions to a surrogate parameter which was projected according to the methods described in Appendix C. The RACT and RACT-2 technology specified in Appendix C was then applied. The actual emissions projected by county are presented in Appendix D and the regional totals are summarized in Table III-2. The results of applying RACT AND RACT-2 controls to the area sources are also presented in Table III-2. Significant reductions, on the order of 90%, can evidently be achieved.

Mobile sources were projected by using DVRPC projections of VMT and the same travel characteristics: speed, temperature, hot/cold start percentages, etc. New emission factors had to be calculated because of the ongoing FMVCP. These calculations were made for the critical years 1977, 1982, 1987, and 1990 and linearly extrapolated to other study years (see Table E-6). The impact of inspection and maintenance (I/M) programs can be calculated using the MOBILE I emission factor program. This was calculated for two programs: a weak program with 15% stringency and mechanics' training and a strong program with 30% stringency and mechanics' training. RACT controls were considered to be a strong I/M program. To apply RACT-2, a 20% transportation control program was assumed. That is, the VMT, hence the emissions, were reduced 20%. The results of these calculations are presented in detail in Appendix E and in summary form in Table III-2.

CHAPTER IV

ESTIMATING THE REQUIRED EMISSION REDUCTIONS

Each of the policy options discussed in the introduction will affect emission levels between now and 1990. Of paramount importance is whether the change in emissions is adequate to attain the oxidant standards by no later than 1987. Of equal importance is whether reasonable further progress requirements will be met between 1979 and the attainment date. In this chapter, we discuss the current method which regulatory agencies are using to relate NMHC emissions to oxidant air quality levels.

Following much study in 1978, a new standard of 0.12 ppm was established for ozone (the principle component of oxidants). This new National Ambient Air Quality Standard (NAAQS), which protects both the public health and welfare, is for a one-hour average period and is not to be exceeded more than once per year. The main thrust of this report addresses the potential for attainment of the new 0.12 ppm ozone standard; however, prior to establishing the new NAAQS, the standard for oxidants was 0.08 ppm, one-hour average. In addition, consideration was given to a new standard of 0.10 ppm during the 1978 study phase. Because of the uncertainty surrounding the level of the standard during preparation of this report, sensitivity analyses were completed assuming the NAAQS set at 0.08 and 0.10 ppm. The results of these sensitivity analyses are reported later in Chapter VI - Potential for Attaining Standard.

In order to attain the selected standard (0.12 ppm), air quality in the Philadelphia AQCR would have to be reduced considerably below current levels. Under the proposed EPA procedures for calculating the necessary reductions, the design on target concentration (current maximum based on 1975, 1976, and 1977 data) for the area would be 0.22 ppm (see Appendix A for definition). By just using a simple proportional relationship and a 0.22 ppm design value, one could quickly calculate that a reduction in NMHC emissions of approximately 45% will have to be achieved in order to attain a 0.12 ppm standard. More detailed methods for calculating the percent reductions are described below.

METHODS FOR RELATING OZONE TO PRECURSORS

The details of the complex process by which ozone is formed are not known; however, it is generally agreed that nonmethane hydrocarbons (NMHC) together with oxides of nitrogen (NO_x) react to form ozone in the presence of light. Hydrocarbons have been selected as the precursor requiring control because above a certain threshold proportion of NO_x, the production of ozone is more sensitive to variations in the NMHC concentration. The reduction of NMHC's is sought only in areas with significant concentrations of NO_x because it is thought that NMHC's in isolation reduce ozone concentrations by the formation of aerosols. Similarly, it is believed that NO_x in isolation deplete ozone through oxidation reactions. The degree of control of NMHC emissions required to limit ozone to specific levels, however, cannot be precisely stated and probably varies with location. Despite this, there has been a succession of increasingly sophisticated approximation techniques. Four approaches have been described by EPA as possible replacement procedures for the old Appendix J curve which was utilized in 1971 at the time of the original submittals of State Implementation Plans to EPA[1]. These are discussed briefly below.

Photochemical dispersion models have the greatest potential for evaluating the effectiveness of ozone control strategies. This potential arises primarily from the spatial and temporal resolution possible with such models and from the ability to relate emissions directly to ambient ozone concentrations as a result of chemistry and atmospheric dispersion. However, data requirements associated with models may be prohibitive in some cases. They are not generally used because (1) the data base required is generally not available; (2) extensive and expensive computational facilities are required; (3) initial and boundary conditions have to be imposed without sure knowledge; and (4) verification has been very limited.

The Empirical Kinetic Modeling Approach (EKMA) considers the chemical kinetics of a column of air transported with its ozone burden and precursor emissions downwind from an urban center. The chemical reactions predicted are based on results of smog chamber experiments with mixtures of propylene, n-butane and NO_x. Aldehydes were added to simulate automobile exhaust. Ozone resulting from irradiating various mixes was then measured and a set of isopleths was eventually developed. These related maximum afternoon concentrations of ozone downwind from a city as a function of morning concentrations of NMHC and NO_x, NMHC and NO_x emitted later, meteorological conditions, reactivity of the mix of precursors, and the concentration of ozone and precursors transported. EKMA is empirical because it requires the use of observed second high hourly ozone concentrations and morning NMHC/NO_x ratios to estimate control requirements. The EKMA reflects an effort which has been underway since December 1975 to develop a substitute for the Appendix J approach.

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[1] Uses, Limitations and Technical Basis of Procedures for Quantifying Relationships Between Photochemical Oxidants and Precursors, EPA-450/2-77-021a, U.S. Environmental Protection Agency, Research Triangle Park, N.C. November 1977.

Linear Rollback, which is even less data-intensive than EKMA, may also be a possible alternative for estimating bounds on control requirements for organic precursors. It is based on the simple but appealing assumption that the concentration of ozone achieved is directly proportional to the amount of precursor emitted. This relationship was used extensively to replace Appendix J when Appendix J fell into disuse because of its very great reduction requirements. However, rollback's failure to consider the dependence of NMHC-ozone relationships on the prevailing NMHC/NO_x ratio during the base period limits applicability of rollback to a first order approximation. Despite the lack of scientific basis, it has been found to be in good agreement with trend data at Los Angeles.

The Modified Rollback is a fourth approach. This method is really a class of approaches which has been labeled "statistical approaches". These may employ simple regression equations, empirically derived envelope curves, stochastic models, and complex multiple regression equations. They basically assume that because they are derived from actual ambient observations they represent more closely the actual phenomenon under study, however complex. They also require the assumption that the relationships derived will apply equally well to a changed situation, regardless of the magnitude of the change, such as will exist when the required reduction is achieved. But, their use is most appropriately limited to considering moderate changes from the base control state because imposition of drastic changes could appreciably modify the functional relationship derived from the base period data.

Although the previously described ozone/precursor relationship can be applied in large urban areas, long range transport still may significantly alter control estimates in some cases. Provided transport can be measured, it can be readily incorporated into photochemical dispersion models, into EKMA, and the modified rollback approach. Transport is composed of a natural background and a manmade contribution. Natural background of ozone appears to be about 0.04 ppm, primarily from slow diffusion from the stratosphere. However, the impact of natural ozone is considerably less in urban areas due to scavenging. The impacts of naturally emitted organics and NO_x on urban ozone are probably much smaller, if not negligible.

REDUCTION REQUIRED FOR ATTAINMENT

Two estimates were made of the reduction in nonmethane hydrocarbon emissions required in the AQCR to attain the 0.12 ppm ozone standard. The two methods described above which are not data intensive and which are generally acceptable were used: EKMA and modified rollback. If one follows the recommended calculation procedure using these methods, the percentage reduction of NMHC emissions required to attain the 0.12 ppm ozone standard would be as follows (see Table IV-1 for an example of the modified rollback calculations):

Calculation Procedure	Percent Reduction
EKMA	69 (with transport)
	66 (no background or transport)
Modified Rollback/ Statistical Procedures	50

By including transport in the EKMA calculation, consideration has been given to the unscavenged ozone transported aloft which is likely to be the component of transport having the greatest impact on maximum afternoon ozone levels observed downwind from cities. Measurements concerning transported organics are very sparse, but they indicate that these organics may be in the order of 0.1 - 0.3 ppm, with concentrations near 0.1 ppm typically found in rural areas upwind from major cities. The role of such levels would typically be to contribute about 0.01 ppm to observed maximum ozone levels near major cities. The resultant local control requirements are probably underestimated when transport is ignored in the EKMA calculation of necessary emissions reduction. The reason for the low estimate is that, in order to attain the NAAQS, local emissions would have to be reduced such that the sum of locally synthesized ozone and the combined impact of manmade and natural transported ozone is 0.12 ppm or less.

TABLE IV-1

EXAMPLE OF MODIFIED ROLLBACK CALCULATION

$$\text{Percent Reduction} = \frac{[C-A(T_o)] - [S-A(T_f)]}{[C-A(T_o)]} \times 100$$

Where:

C = design ozone concentration (ppm)
A = additivity factor (assumed to be 0.5)
T_o = concentration of transported ozone (including natural background) associated with the design ozone concentration (ppm)
S = ozone standard (ppm)
T_f = concentration of transported ozone (including natural background) after ozone standard is attained (ppm)

Therefore:

$$\text{Percent Reduction} = \frac{[.22-.5(.08)] - [.12-.5(.06)]}{[.22-.5(.08)]} \times 100 = 50$$

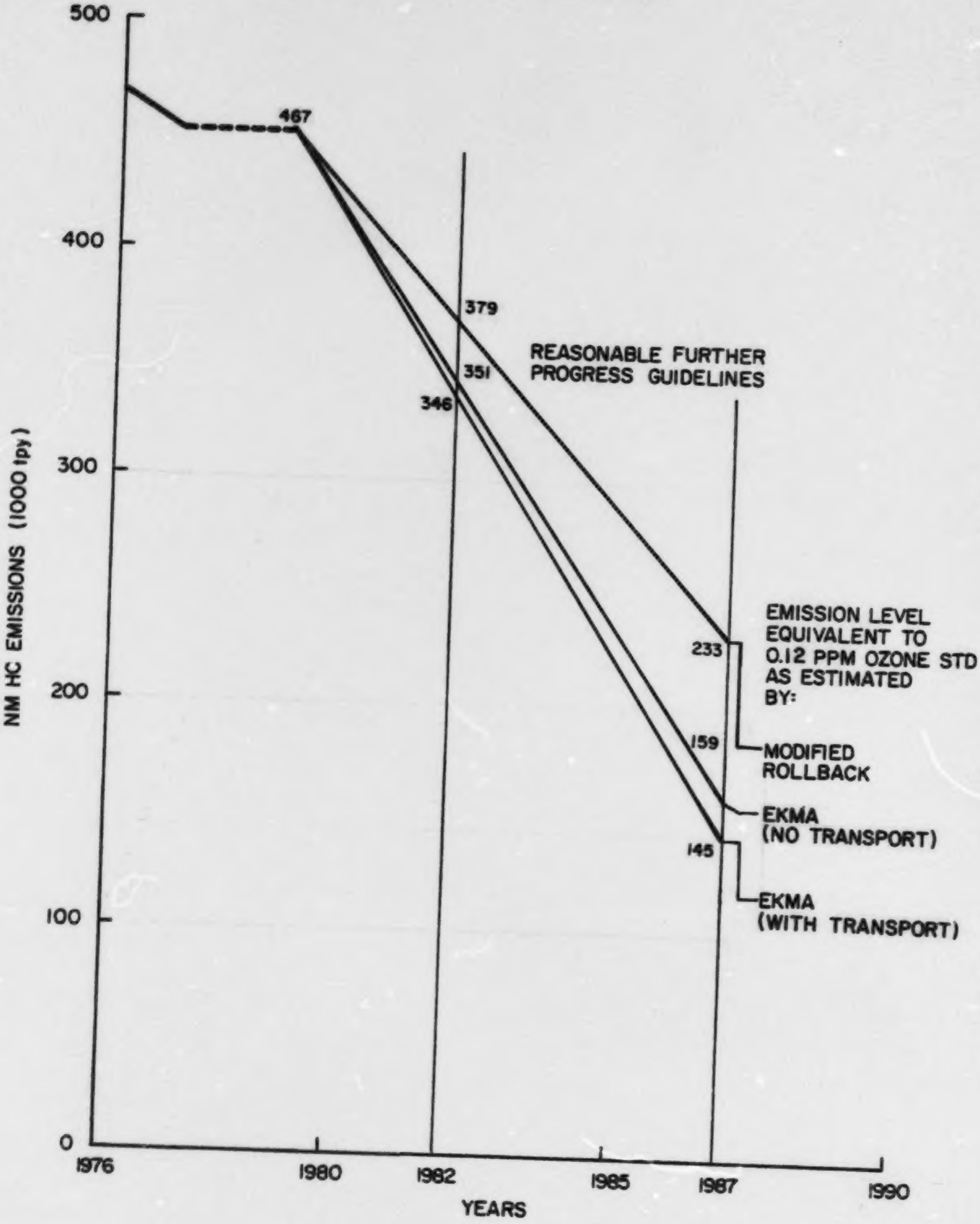
EPA believes that the scientific basis for EKMA is much stronger than for rollback. Based on theory supported through smog chamber studies, EPA's Monitoring and Data Analysis Division believes that rollback will frequently underestimate the need for NMHC reductions and that EKMA will generally provide a more reliable estimate. Unfortunately, EKMA has not yet been fully validated in field studies. For this reason and because of the current widespread use of the rollback technique, considerable latitude has been allowed to EPA's Regional Offices in accepting either EKMA or modified rollback. Both values are considered in the subsequent analysis. To calculate the 1987 emissions goal required to attain the NAAQS of 0.12 ppm ozone, the 1977 emission level of 466,513 tpy was reduced by 69% to 144,619 tpy and by 66% to 158,614 tpy reflecting EKMA with and without consideration for transport (see Figure IV-1). For modified rollback, the 1977 emission level was reduced by 50% to 233,256 tpy.

REASONABLE FURTHER PROGRESS

The Clean Air Act amendments of 1977 require that if all reasonable control measures will not bring about attainment by 1982 then attainment no later than 1987 must be guaranteed by specifying the measures which will be adopted. Furthermore, these measures must be adopted in time to demonstrate reasonable further progress (RFP). EPA defines RFP for 1982 by a linear interpolation between the 1977 emission level and the emission level required for attainment in 1987. However, the 1977 emission level is to be plotted as if it were still occurring in 1979 at the time of SIP revision approval. Ordinarily, emission levels in 1979 would be expected to be less than the 1977 emission level even though there is growth of major point, mobile, area, and minor point sources. However, the overall emissions decrease primarily because of the FMVCP. The RFP lines defined by the two estimates of the reduction needed for attainment are presented in Figure IV-1. To attain the 0.12 ppm ozone standard, the 1982 emissions goals using the EKMA with and without consideration for transport were calculated to be 345,803 and 351,051 tpy, respectively. Using modified rollback, the 1982 emissions goal was calculated to be 379,042 tpy.

FIGURE IV-1

REASONABLE FURTHER PROGRESS AND POTENTIAL FOR ATTAINMENT



CHAPTER V

GROWTH AND PROGRESS TOWARD ATTAINMENT (1976-1982)

In this chapter, the impact on emissions over time which would be expected from implementation of each of the policy options described in Chapter I are analyzed. Analyses were conducted for the period 1976 through 1990 and the discussion in this chapter centers around the Clean Air Act's "reasonable further progress" (RFP) requirement in 1982. Presumably, the Commonwealth of Pennsylvania will be submitting a "two stage SIP" because it is extremely doubtful that attainment in 1982 can be realized. Workshops presented by EPA have indicated that by 1982 each state must show that its overall emission reduction program is on schedule. For this study, base year emissions in all source categories were augmented or reduced according to growth and control technology changes dictated by each policy option. Emissions during the years 1979, 1980, and 1981 reportedly are not critical as long as emissions do not increase above the 1979 level. In a subsequent chapter, each of the policy options is examined for its potential for ensuring attainment with the 0.12 ppm ozone standard by December 31, 1987 as required by the Clean Air Act Amendments of 1977. It was assumed that none of the examined policies could be fully implemented and in effect until 1980. Therefore, the emission levels for the policies analyzed were assumed to be the same for the period 1976 through 1979. The levels deviate after 1979 and this deviation is examined below to determine whether the emission reduction achieved meets the criteria for RFP derived in Chapter IV.

I: PRE-1979 SIP WITH MAJOR SOURCE CONSTRUCTION

An analysis was made of emission levels assuming that the pre-1979 SIP would remain in effect through the year 1990. It was further assumed that existing permitting procedures used by the state and local air pollution control agencies would also remain in effect over this period. Under these procedures, all new expansions would require LAER control technology. The EPA offset policy was assumed to be in effect requiring 1:1 offsets for major source growth in 1977 through 1979; but, no emission offset policy was assumed to be in effect after 1979. Under this scenario, no emission reductions were required for existing major sources. Area and minor stationary sources were assumed to grow, but have no more controls than in the base year 1976. Mobile source emissions were assumed to grow without transportation control plans and without inspection and maintenance (I/M) programs.

This particular scenario was not a policy option that was being considered by EPA, but rather reflected the change in emissions and resultant air quality if there were no SIP revisions. Reductions in emissions resulted only because of the Federal Motor Vehicle Control Program (FMVCP).

As previously indicated, the EPA offset policy was assumed to be in effect requiring 1:1 offsets for major source growth in 1977, 1978, and 1979. Major source has the same meaning in this study, as applied to that offset policy, and all growth of sources with 100 tpy potential which occurs in increments of 50 tpy or more, actual, must be offset. Major source growth through 1990 was only 2,080 tpy in the over 50 tpy category which requires offsets, 1,549 tpy in the less than 50 tpy category. Assuming the growth rate was uniform, 1,555 tpy would have been the increase in major source emissions by 1982. However, offsets in the 1977 to 1979 interval would have reduced that by 447 tpy so that the major source growth would be just over 1,100 tpy. All major source growth was assumed to require LAER.

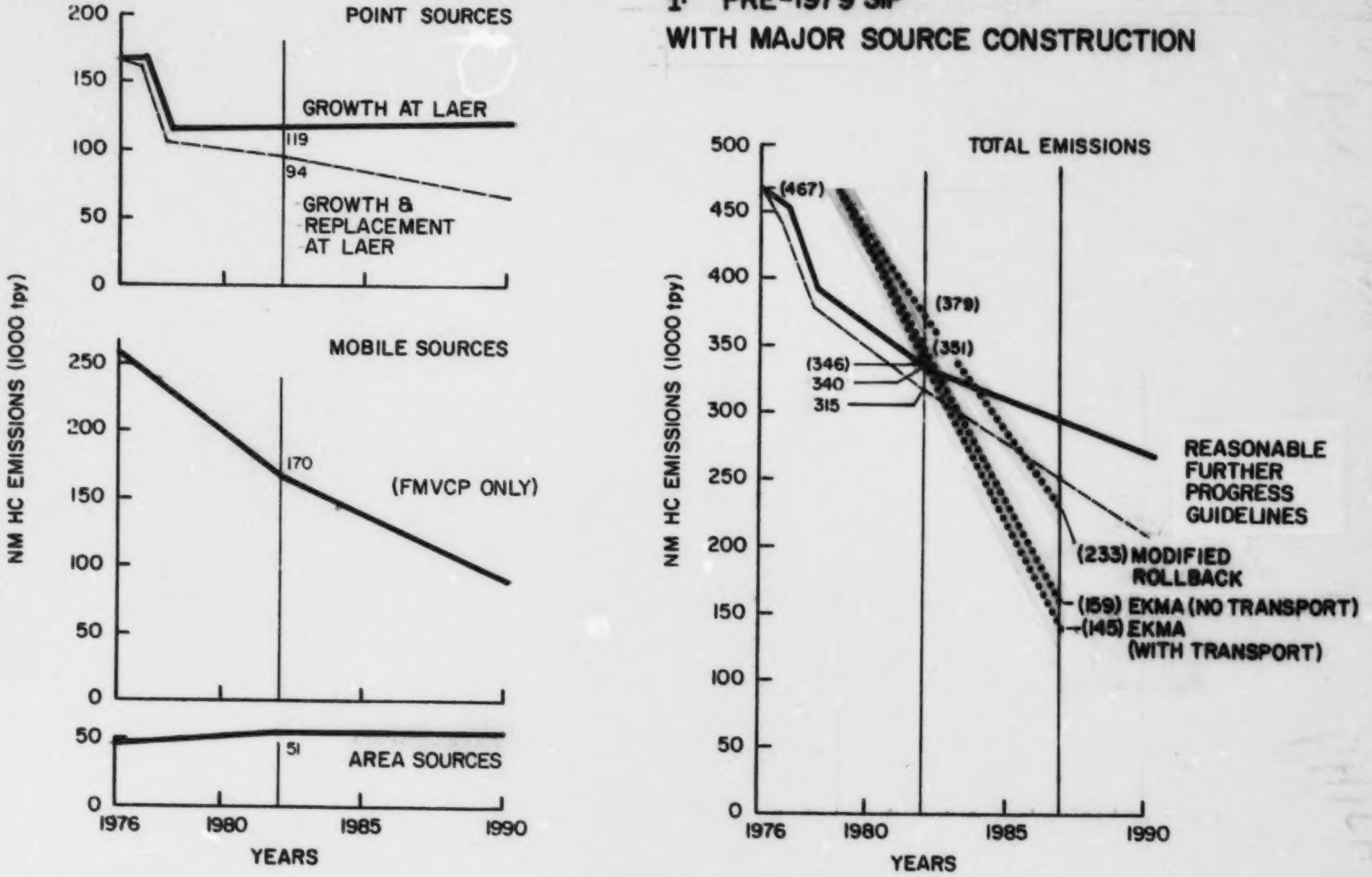
During this period, in fact in 1978, a reduction of 50,249 tpy occurred as a result of two facilities coming into compliance with the pre-1979 SIP. One of these is a cluster of nine wastewater separators emitting a total of 9,952 tpy which was required under the pre-1979 SIP to reduce emissions to 995 tpy. The other, a petroleum storage tank farm, consisting of 100 fixed-roof tanks, was required to reduce emissions under the pre-1979 SIP from 43,465 tpy to 2,173 tpy. Both sources were required to comply by mid-1978 and this large reduction will be a common feature of all policy options examined.

The results of this policy option are presented in Figure V-1. In the figure, changes in emissions are tracked separately and together. Area sources increase from roughly 47,000 to 51,000 tpy (approximately 8.5%) in 1982. The FMVCP causes significant reduction from 252,000 to about 170,000 tpy (approximately 32.5%) by 1982. To the major source changes cited above must be added the minor source increase of about 700 tpy over the six-year period to 1982. Thus, the point source total begins at about 168,000 tpy in 1976; experiences the 50,000 tpy reduction due to compliance with the pre-1979 SIP in 1978; and grows back to the 119,000 tpy level by 1982.

SIP

FIGURE V-1

I: PRE-1979 SIP WITH MAJOR SOURCE CONSTRUCTION



Assuming uniform replacement of retired equipment at the rates derived in Appendix D, the dashed line is drawn on Figure V-1 in the point source block. It represents the difference between the actual emissions of equipment being retired and the LAER emissions of equipment of the same capacity which replaces it. If the assumptions hold, this amounts to about 59,000 tpy by 1990. By 1982, it would be quite significant reducing the point source total from 119,000 to 94,000 tpy (approximately 21%).

When the three components are added together the decrease in total emissions can be tracked. Only two of the components produce this decrease: the 50,000 tpy loss in 1978 when two point sources came into compliance and the continuous decrease attributable to the FMVCP. Point source emissions would eventually grow back to the base year level. However, replacement of obsolete facilities with LAER control technology more than counters this tendency and produces net point source loss each year. Total emissions in 1982 are reduced from 467,000 to about 340,000 tpy (27%) assuming growth at LAER and to about 315,000 tpy (33%) assuming growth and replacement at LAER. When the RFP guidelines are considered, the emission level attained by 1982 is below the two emissions goals. This constitutes RFP by both modified rollback guidelines and the more conservative EKMA guide.

II: RACT SIP WITH MAJOR SOURCE CONSTRUCTION

In this policy option, existing sources had to reduce emissions to the RACT level. Different industrial processes were required to adopt RACT controls in compliance with a series of SIP revisions which were assumed to be promulgated from 1979 to 1982. The schedule assumed was the schedule presented in Chapter III and Appendix C for the initial EPA guideline documents. The proposed compliance schedule gave industry several years to meet the new emission requirements. This schedule was used to achieve the required reduction by compliance dates varying from 1982 to 1986. To test the impact of delays in issuance of the guideline documents, a sensitivity analysis was performed. The results of this analysis are presented later in Chapter VI - Potential for Attaining Standard. Again, it was assumed in this scenario that all major source growth met LAER.

Area sources also were controlled at RACT with reduction to this level (compliance) assumed by 1982. Mobile sources in this option were controlled by

FMVCP and in addition, to meet the RACT requirement, a strong I/M program was begun in 1980. Strong, in this study, implied a 30% stringency factor and a mechanics' training program.

Figure V-2 illustrates the emission trends for the three source categories and their sum over the study period. Area sources were seen to increase 8-9% from 1976 to 1980 and then realize an 84% reduction with RACT SIP compliance from about 51,000 to about 8,000 tpy in 1982. The mobile sources provided the same 13-14,000 tpy decrease as in the base case; but, beginning in 1980, a slightly greater reduction rate resulted from the initiation of an I/M program. This produced an additional 12,000 tpy (7%) reduction by 1982, 158,000 instead of 170,000 tpy.

The point sources were subject to the EPA offset policy through 1979 but no offset policy beyond that. They experienced the decrease in 1978 due to compliance of the tank farm and wastewater separators noted previously. Then in 1982, 1984, and 1986, three additional reductions occurred as compliance with the RACT SIP was achieved. The point source total in 1982 was reduced to 90,000 tpy as contrasted with 119,000 tpy in the base case.

The effect of replacement of depreciated assets was also tracked in this option. A comparison of Figure V-1 with Figure V-2, shows, however, that although a lower absolute level was achieved in Policy Option II with LAER replacement, the reduction due to replacement was smaller. This is because in Policy Option I, replacement at LAER caused emissions to change from pre-1979 SIP to LAER; while in Policy Option II, it caused reduction from RACT to LAER, a lesser reduction. The absolute level was lower because many sources were at RACT by 1982 in Policy Option II.

When total emissions were tracked and compared with RFP guidelines in 1982, the emission level was seen to be well below the requirement for RFP as estimated by both modified rollback and EKMA.

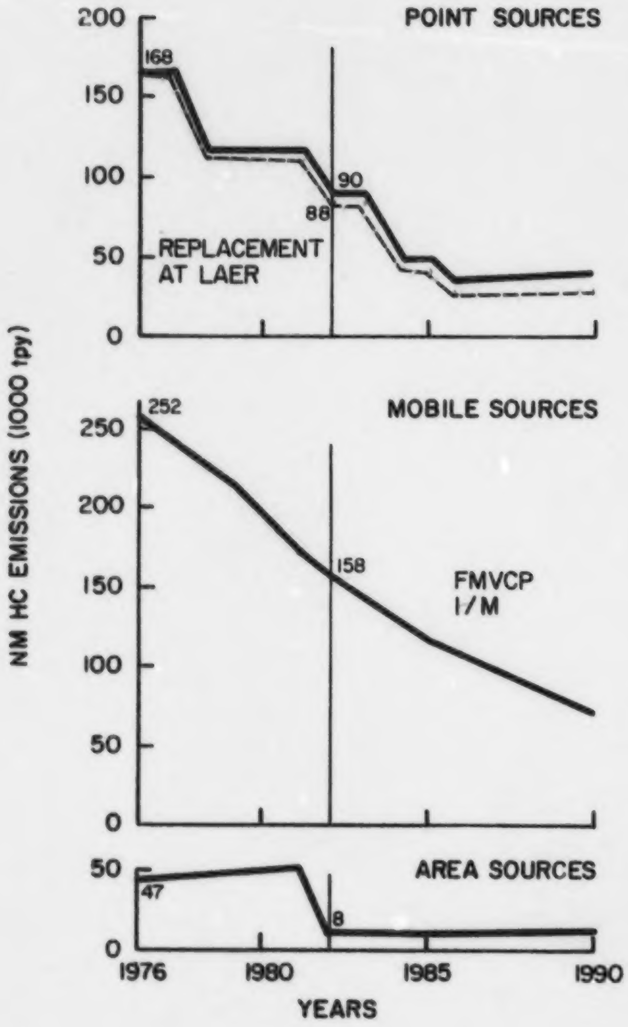
III: RACT SIP WITH OFFSETS FOR NEW MAJOR SOURCE CONSTRUCTION

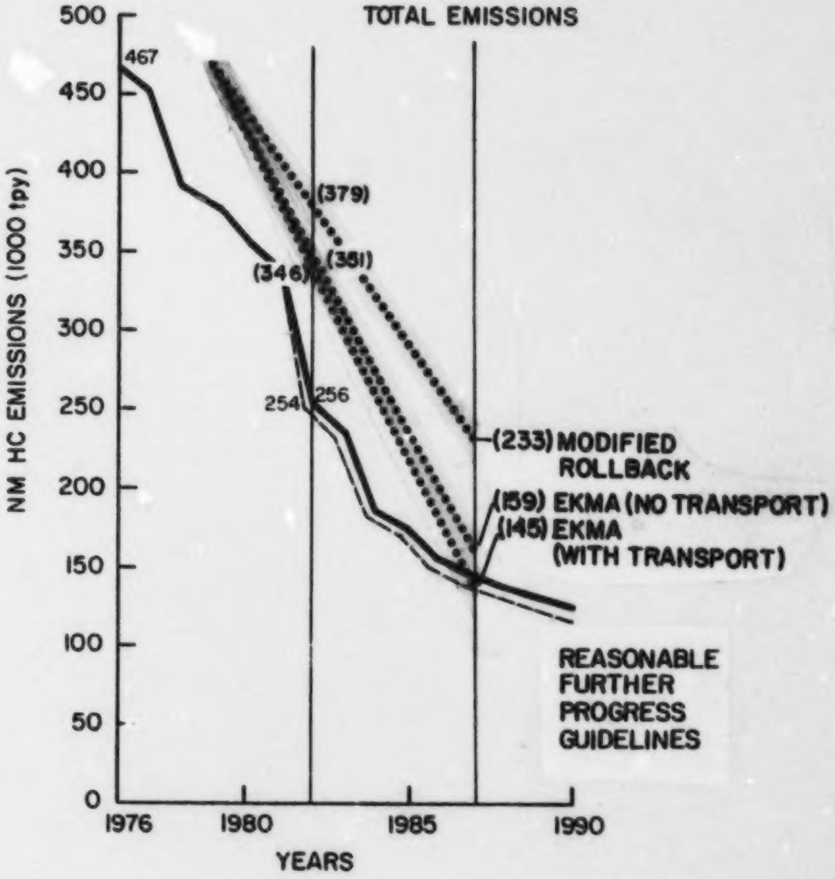
In nonattainment areas, new major source growth can be accommodated if either the SIP revision requires sufficient emission reduction from existing sources for such growth or if an emission offset program is established. The potential

FIGURE V-2

II:

RACT SIP WITH
MAJOR SOURCE CONSTRUCTION





effect of an emissions offset policy is analyzed in this policy option. New sources were assumed to require offsets from 1977 to 1979 in accordance with the existing EPA offset policy; in the following years, 1980 to 1990, the SIP revision was assumed to provide for emission offsets. For all new major source construction in this period, the new source emissions at LAER levels had to be offset by at least an equal amount from existing sources. The offset ratio can be varied, so a 1:1 ratio and a 3:1 ratio were considered here.

For this scenario, area sources were controlled at RACT levels by 1982 when compliance with the 1979 SIP revision was required. Mobile sources were controlled through the FMVCP with a strong I/M program beginning in 1980. Minor source growth took place at RACT and as RACT controls were applied they were applied to all point sources both major and minor in the controlled categories. Major source growth in less than 50 tpy increments required LAER but not offsets. Offsets needed for major new source growth exceeding 50 tpy were provided by applying RACT controls to the inventory at the time the offset was required. However, as soon as RACT controls became part of the SIP, they were no longer available as offsets. As pointed out in Table III-3, as the RACT SIP was adopted many potential offsets were eradicated. Thus, in the early years many offsets were available; however, since all industries were required to have RACT controls by the 1982 SIP revision, only LAER offsets were available after 1982. These were the emission reductions that could be realized by applying control technology more stringent than RACT. Because of the small growth demand in the Philadelphia AQCR, the 15,000 tpy of LAER offsets available were adequate to accommodate all growth throughout the study period with the offset ratios studied.

1:1 Offset Ratio

Table V-1 illustrates the emission analysis considering growth and offsets for major point sources growth on a 1:1 offset basis. The table shows the growth in each increment category which was expected each year. Initially, 80,581 tpy RACT offsets and 15,391 tpy LAER offsets were available. They were depleted as offsets were required each year and as the RACT SIP was promulgated. Point source emissions were increased by the minor source growth at RACT and the major source growth in less than 50 tpy increments which took place at LAER; they were not increased by the major source growth requiring offsets because

TABLE V-1

ANALYSIS OF CHANGES IN NMHC EMISSIONS UNDER THE EMISSION OFFSET POLICY ASSUMING MAJOR POINT SOURCE GROWTH ≥50 tpy REQUIRES OFFSETS AND GROWTH IS STEADY IN TIME

(All entries in tons/year)

	SOURCES				GROWTH				
					MAJOR		MINOR	AVAILABLE OFFSETS	TOTAL EMISSIONS
	AREA	MOBILE	MINOR	MAJOR	≥50	<50			
1976	46,534	252,410	15,571	152,001(1)			118	80,581	466,516
1977	46,364	237,788	15,689	152,112	149	111	118	80,432	452,953
1978	48,194	223,166	15,807	101,974(2)	149	111	118	80,283	389,141
1979	49,024	208,544	15,925	102,085	149	111	118	50,858(3)	375,578
1980	49,852	185,936	16,041	102,196	149	111	118	10,445(5)	354,560
1981	50,387	171,729	16,161	102,307	149	111	118	10,296	340,584
1982	8,137	157,523	10,141	79,280(4)	149	111	118	0(7)	255,081
1983	8,231	143,316	10,259	79,391	149	111	118	(15,242)	241,197
1984	8,326	129,110	8,730	40,885(6)	149	111	118	(15,093)	187,051
1985	8,420	114,903	8,846	40,996	148	111	118	(14,945)	173,165
1986	8,504	106,066	8,966	30,959(8)	148	110	118	(14,797)	154,495
1987	8,588	97,229	9,083	31,069	148	110	117	(14,649)	145,969
1988	8,671	88,391	9,200	31,179	148	110	117	(14,501)	137,441
1989	8,755	79,554	9,317	31,289	148	110	117	(14,353)	128,915
1990	8,839	70,717(9)	9,434	31,399	148	110	117	(14,205)(10)	120,380

NOTE: For footnotes, see following page.

TABLE V-1 (Continued)

FOOTNOTES:

(1) Includes 50,249 tpy from two sources scheduled to be in compliance by 1978.

(2) Compliance achieved with current SIP.

(3) SIP revision affecting area, mobile, and point (29,276 tpy) sources. Compliance required by 1982.

(4) Compliance achieved with first SIP revision.

(5) SIP revision affecting point sources (40,264 tpy). Compliance required by 1984.

(6) Compliance achieved with second SIP revision.

(7) SIP revision affecting point sources (11,041 tpy less offsets already used.) Compliance required by 1986.

(8) Compliance achieved with third SIP revision.

(9) Aircraft engine replacement begun in 1985, 75% complete.

(10) LAER offsets appear in (); they are assumed to be available throughout but are used, because of cost factors, only after RACT offsets are depleted.

offsets were available and used. In 1982, however, the RACT offsets were entirely eradicated and further growth had to be offset by LAER emissions. Note that in 1982 the effectiveness of the SIP revision was reduced by the amount of offsets used previously: only 10,147 tpy could be credited to the SIP revision instead of 11,041 tpy. The substitution of LAER offsets was made because they were, in principle, available and remained available throughout the study. In the real world, they might not be used because of the expense involved in realizing this degree of control.

The graphs of these changes in the emission levels of the three general source categories and their sum are presented in Figure V-3. As in the case of the RACT SIP, the area sources were reduced by 84% from 51,000 to 8,000 tpy in 1982. The mobile sources showed the result of the FMVCP augmented by the strong I/M program beginning in 1980, reaching again the level of 158,000 tpy by 1982. The point sources showed the large reduction due to compliance of the tank farm and wastewater separators in 1978 and the three compliance steps associated with the RACT SIP revisions in 1982, 1984, and 1986.

When total emissions were considered, the emission levels were almost the same as in the RACT SIP because of low levels of growth. The RFP requirement was easily achieved according to either estimate of the 1982 emissions goal.

3:1 Offset Ratio

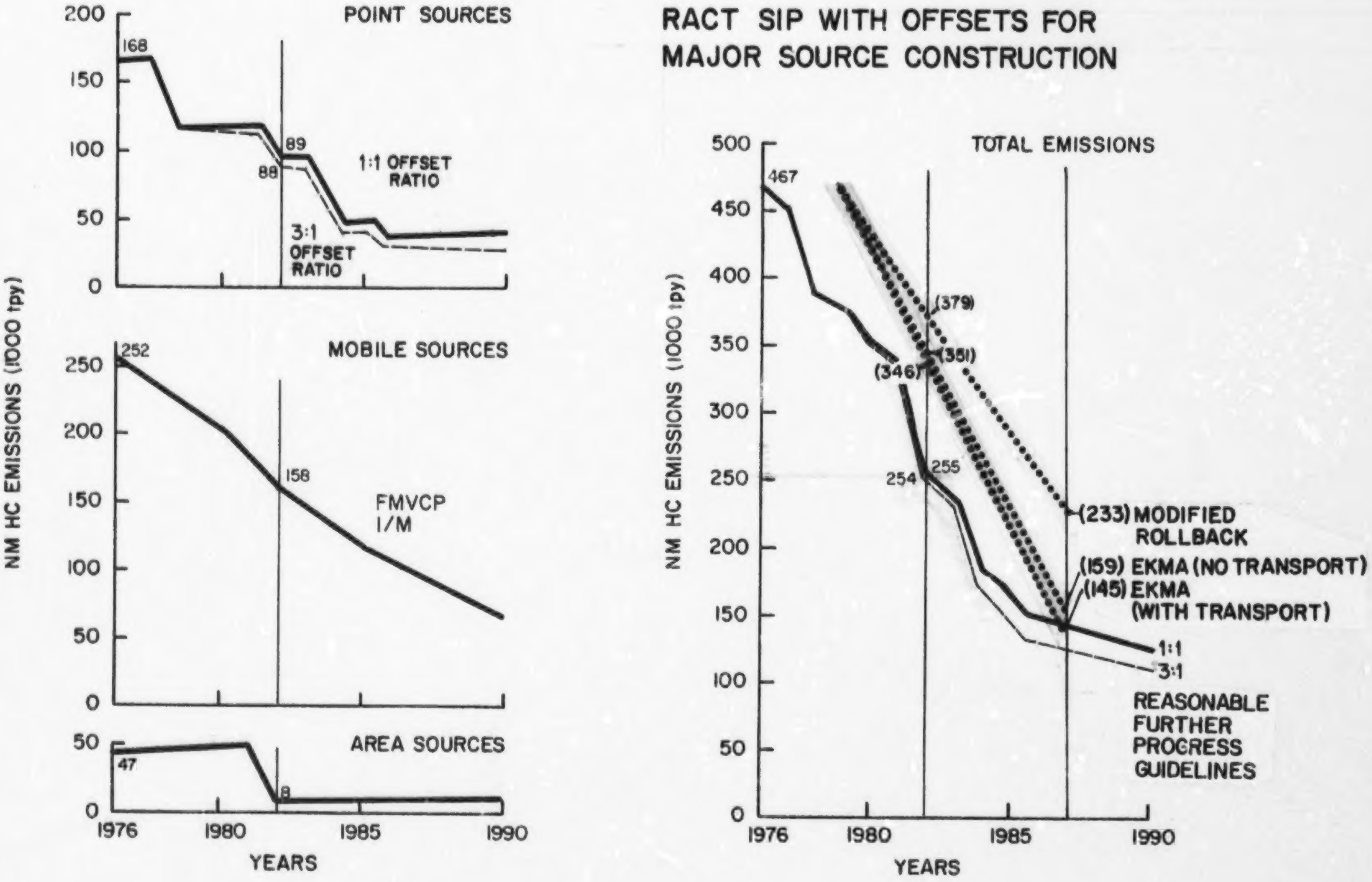
In this variation of the offset policy option, the emission offset ratio was considered to be 3:1 instead of 1:1. Thus, for every ton/year of major new source emissions in the 50 tpy category that was added, three ton/year were removed by reducing emissions from existing sources making a net benefit of two ton/year. The effect of this change in offset ratio can be seen in the graphs of Figure V-3 where the dashed line in the point source block represents the 3:1 offset variation. By 1982, only an additional 1,000 tpy could be realized which grows only slightly with time, the differences being only slightly greater in 1987.

The offset policy in these scenarios is seen to be relatively ineffective in achieving emission reduction, however good it may be at accommodating growth. In the situation where it is operating simultaneously with the adoption of the staged RACT SIP revisions, the apparent emission reduction due to using RACT

FIGURE V-3

III:

RACT SIP WITH OFFSETS FOR MAJOR SOURCE CONSTRUCTION



offsets proves to be no long term reduction at all. The reduction can only take place once and was scheduled to take place with or without an offset policy. However, when LAER offsets are finally used a real reduction is realized since, except for the offset policy, these reductions would only take place upon retirement of the facility with LAER replacement.

This variation of Policy Option III also easily met the emission reduction requirements of RFP.

IV: RACT SIP WITH NO MAJOR SOURCE CONSTRUCTION AFTER 1979

In this policy option, emission changes were analyzed assuming all existing sources were controlled to the RACT level, but assuming that no new major source construction could take place. The RACT SIP revisions were assumed to be adopted and complied with according to the EPA's CTG schedule discussed previously. Area sources were controlled at the RACT level, compliance with the 1979 SIP revision being required by 1982. Mobile sources were controlled through the FMVCP supplemented by a strong I/M program beginning in 1980. Minor source growth took place at RACT and existing minor sources were required to comply with the RACT SIP revisions also.

Figure V-4 shows essentially very little difference between this policy option and Policy Option II because of the slow growth rate projected for the Philadelphia AQCR.

The principal point source reduction was achieved by compliance of the tank farm and wastewater separators with the pre-1979 SIP in 1978 and the compliance steps associated with the RACT SIP revisions. Area source compliance by 1982 achieved an 84% reduction then. Mobile sources were reduced by the FMVCP augmented by a strong I/M program beginning in 1980.

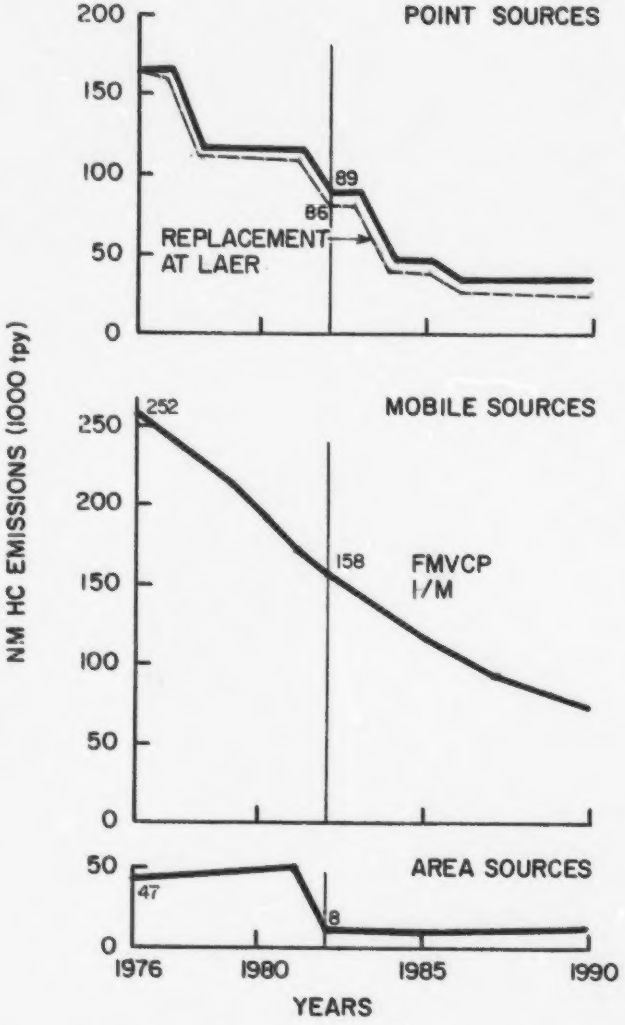
The additional reduction achieved by prohibiting major source construction was small, but it assured that the RFP requirement would be easily met in 1982.

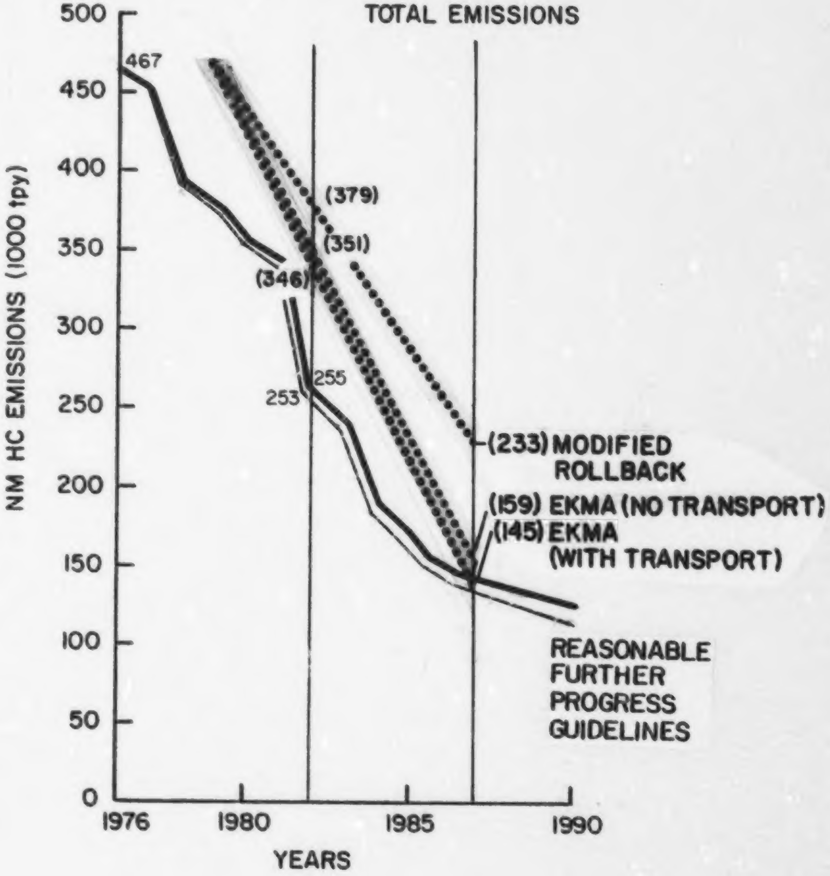
The effect of replacement at LAER is seen to have the same small effect as in Policy Option II, again because many sources have been required to reduce to RACT by the SIP revision. Replacement at LAER after reduction to RACT is less than it might have been if replacement had taken place earlier at the current SIP.

FIGURE V-4

IV:

RACT SIP WITH NO MAJOR
SOURCE CONSTRUCTION AFTER 1979





V: LAER REPLACEMENT WITH NO MAJOR SOURCE CONSTRUCTION AFTER 1979

This policy option was devised as a theoretical "best case" to determine emission levels if the entire economic base were replaced by 1990 using the best control for new sources. In this option, the only major industrial source growth permitted in the AQCR after 1979 was the replacement of existing sources potentially lost due to retirement after 1979. Furthermore, replacement of existing capacity was assumed to take place completely and uniformly over the interval from 1979 to 1990 and such sources would use LAER control technology. No new plants were assumed to locate in the study area and no increases in capacity were assumed. This option produced the greatest emission reduction possible for the area, for the same level of economic activity.

Prior to 1979 all growth was permitted, the EPA offset policy being in effect with offsets available. Subsequently, minor source growth was permitted but major source growth was curtailed. Area sources were controlled to the RACT-2 level, again complying by 1982. The mobile sources, in addition to the FMVCP and the strong I/M program initiated in 1980, had a 20% transportation control program imposed in 1985. This program reduced VMT, hence emissions, by 20%. As stated before, after 1979 major sources retrofitted LAER at a uniform rate.

Figure V-5 is the graph of these emission level changes with time. It shows clearly the area source compliance with RACT-2 and the additional mobile source programs. The point source curve shows the emissions experience uniform reduction due to LAER replacement after compliance with the pre-1979 SIP is achieved in 1978. The RFP requirement was easily achieved.

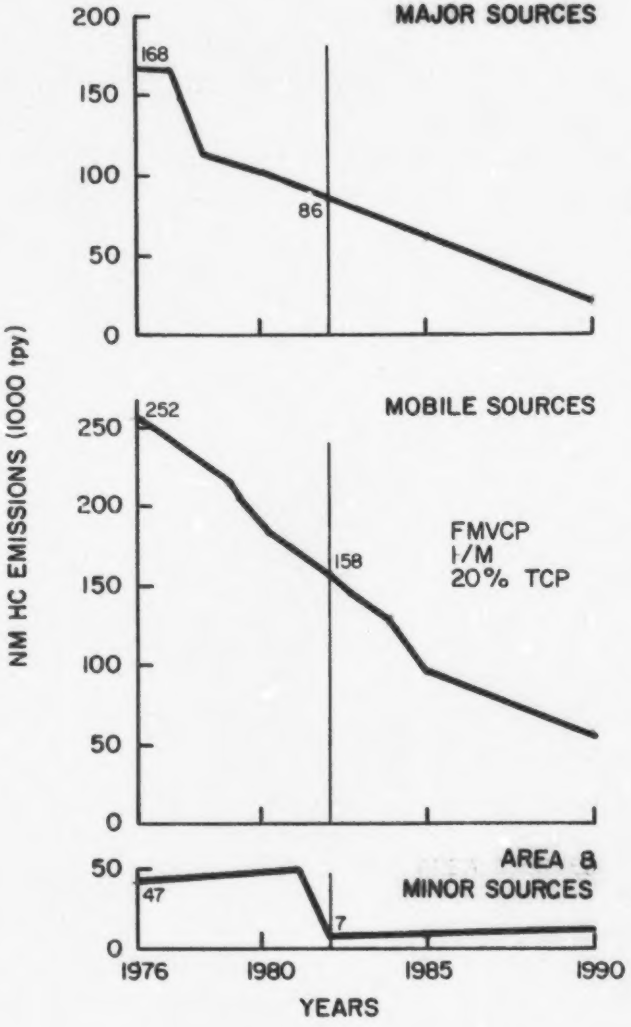
COMPARISON OF PROJECTED EMISSIONS

Table V-2 considers the five policy options analyzed and compares the emissions projected under each option with the RFP requirement for emissions in 1982. The RFP emission requirement in 1982 to move toward the 0.12 ppm standard was 345,803 and 351,051 tpy as estimated by EKMA with and without consideration of transport, respectively. Using modified rollback, the 1982 emission goal was 379,042 tpy. All future scenarios studied had reached emission levels below these values by 1982.

FIGURE V-5

V:

LAER REPLACEMENT WITH NO MAJOR SOURCE GROWTH AFTER 1979



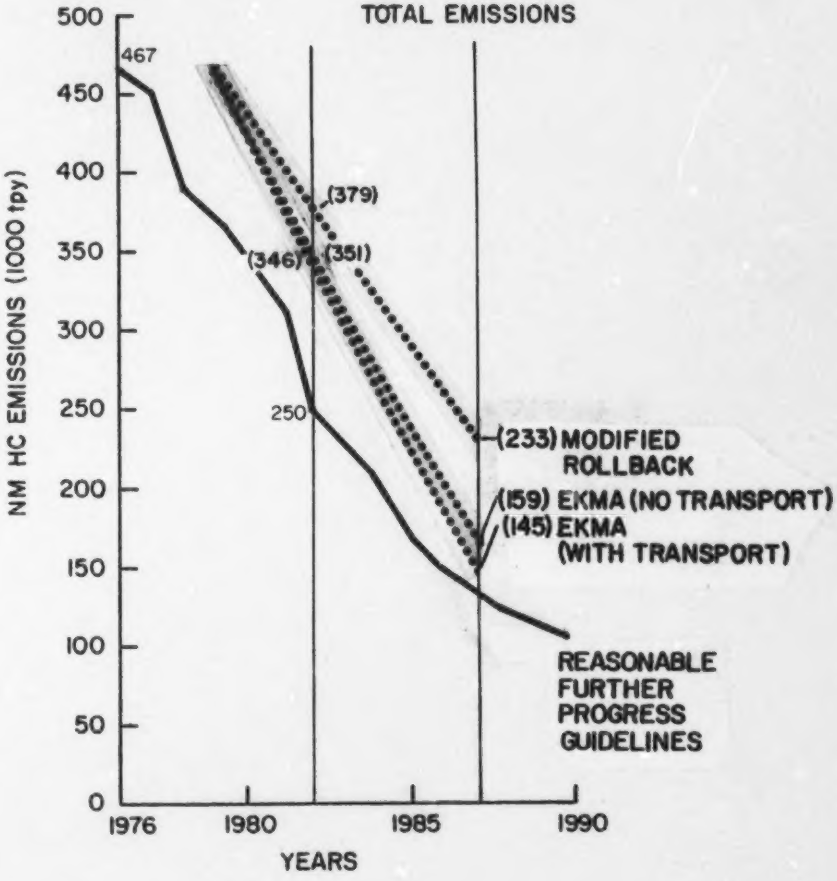


TABLE V-2

COMPARISON OF PROJECTED EMISSIONS WITH THE REASONABLE FURTHER PROGRESS REQUIREMENT UNDER VARIOUS POLICY OPTIONS

FUTURE SCENARIOS	PROJECTED 1982 EMISSIONS[1] (tpy)	FURTHER REDUCTIONS REQUIRED[2] (tpy) ROLLBACK	EKMA
I. Base Case: Pre-1979 SIP with Major Source Construction	339,687	0	0
- with replacements at LAER	314,430	0	0
II. RACT SIP with Major Source Construction	255,519	0	0
- with replacements at LAER	253,269	0	0
III. RACT SIP with Offsets for Major Source Construction			
- 1:1 offset ratio	255,081	0	0
- 3:1 offset ratio	253,889	0	0
IV. RACT SIP with No Major Source Construction after 1979	254,415	0	0
- with replacements at LAER	252,165	0	0
V. LAER Replacement with No Major Source Construction after 1979	250,292	0	0

---

[1] Represents the current schedule for phasing-in RACT SIP adoption over the period 1979-1982 and compliance over the period 1981-1986.

[2] The RFP emission requirement in 1982 to move toward the 0.12 ppm standard was 345,803 and 351,051 tpy as estimated by EKMA with and without consideration of transport, respectively. Using modified rollback, the 1982 emissions goal was 379,042 tpy.

CHAPTER VI

POTENTIAL FOR ATTAINING STANDARD

In Chapter IV, the reduction in nonmethane hydrocarbon (NMHC) emissions required to attain the 0.12 ozone standard was calculated. Two methods were used: modified rollback, which has some empirical support but no theoretical basis, and EKMA, which is a procedure that relies partly on empiricism and partly on theoretical grounds. Rollback estimates indicate that a 50% reduction will result in attainment; EKMA estimates are more conservative and require a 69% reduction with consideration of transport and 66% if transport is not considered. Applying these figures to the initial emission inventory, we arrive at the range of emissions equivalent to the 0.12 ppm standard: 144,619 to 233,256 tpy. In this chapter, the potential emission reductions achieved by the policy options studied are considered at the statutory time limit, December 31, 1987. The question of attainment is focal. Then, the reliability of results is tested by considering their sensitivity to variations in assumptions and values assigned to basic parameters.

POTENTIAL FOR ATTAINMENT

I: Pre-1979 SIP With Major Source Construction

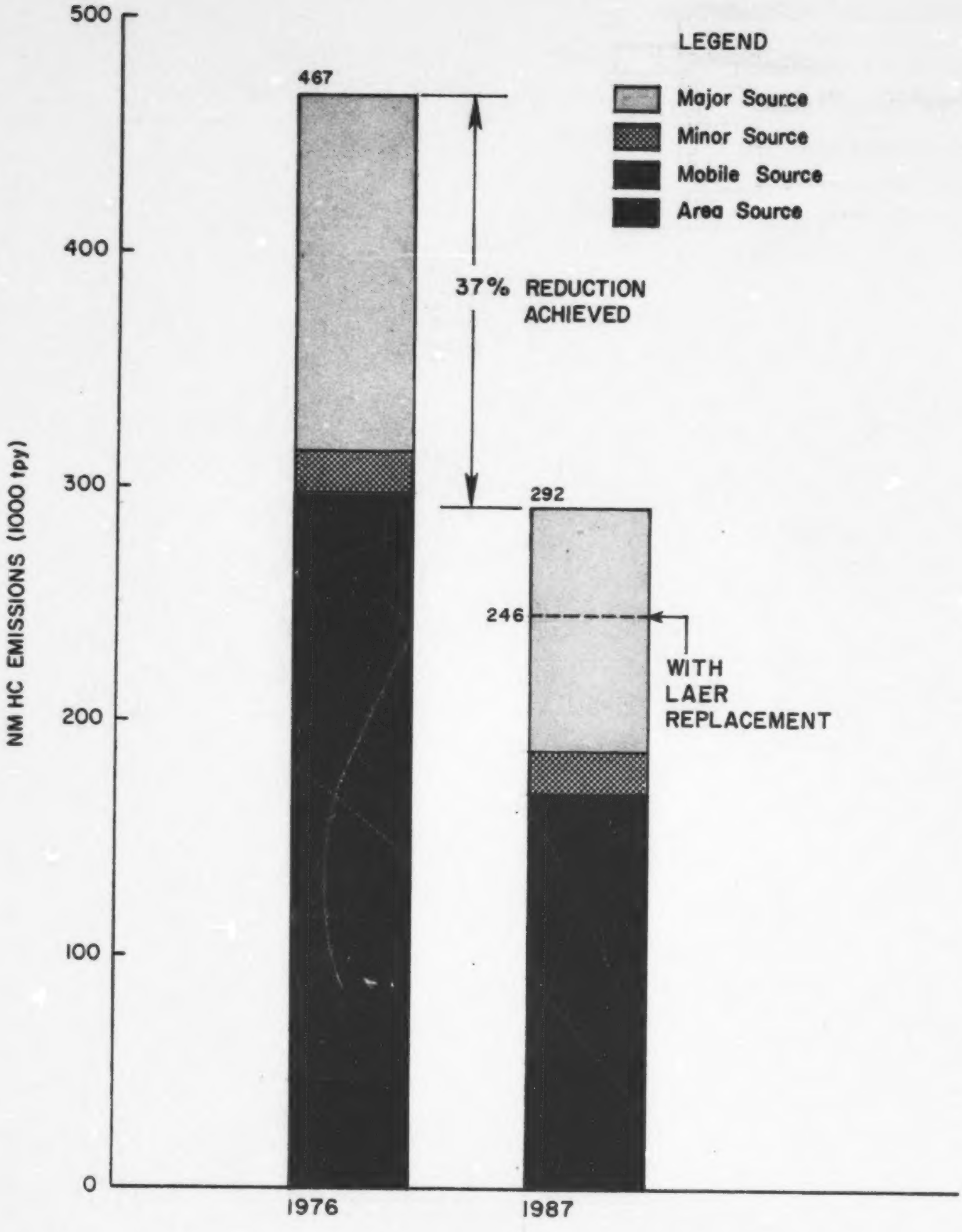
This policy represented the worst case situation for air quality and emissions; it was examined to illustrate the change in emissions if nothing were done to change regulations or control pollution sources more stringently.

The hydrocarbon reduction needed to attain the 0.12 ozone standard by 1987 was not achieved in this base or "No Action" case. There were only two sources of decreasing emission levels in this policy option: compliance of the tank farms and wastewater separators with the pre-1979 SIP in 1978 which achieved a 50,249 tpy reduction, and the Federal Motor Vehicle Control Program (FMVCP), which achieved a 155,181 tpy reduction. Both of these are independent of policies considered here.

Figure VI-1 is a bar diagram comparing emissions in the base year (1976) with the 1987 emissions under this base case. Total emissions of about 467,000 tpy were reduced to 292,000 tpy. This amounts to a 37% reduction, most of it in the mobile source component which decreased by 54% under the FMVCP from 252,410 to 117,329 tpy.

FIGURE VI-1

I: PRE-1979 SIP WITH MAJOR SOURCE CONSTRUCTION



Minor and area sources showed only small increases over this period which is a manifestation of the stability of the Philadelphia region.

When LAER replacement of existing facilities was considered to have taken place at the retirement rate suggested in EPA guidelines (assuming the useful life is twice the period allowed by IRS for depreciation), the emission level was about 246,000 tpy. This is still about 13,000 tpy greater than the higher estimate of the level needed to attain.

II: RACT SIP With Major Source Construction

The RACT SIP brings about emission reductions in three ways:

- It requires more stringent control of existing stationary sources by defining and requiring RACT technology on a case by case basis.
- It imposes controls on area sources, which are in general sources too small or numerous or mobile to require registration.
- It imposes a strong inspection/maintenance (I/M) program on motor vehicles which reduces emissions below the level achieved with the FMVCP only.

The RACT SIP relies on the initial EPA control technology guidelines and was considered to be implemented on the EPA publication schedule. This stepwise implementation produces stepwise reduction in emissions as compliance is achieved in one industrial sector after another. This process is best illustrated in the graphs of Chapter V which show actually four compliance steps: one in 1978 as compliance with the pre-1979 SIP is wholly achieved followed by the three-step compliance with the RACT SIP revisions in 1982, 1984, and 1986. To test the impact of delays in issuance of the control technology guidelines, a sensitivity analysis was performed. The results of this analysis are presented later in this chapter.

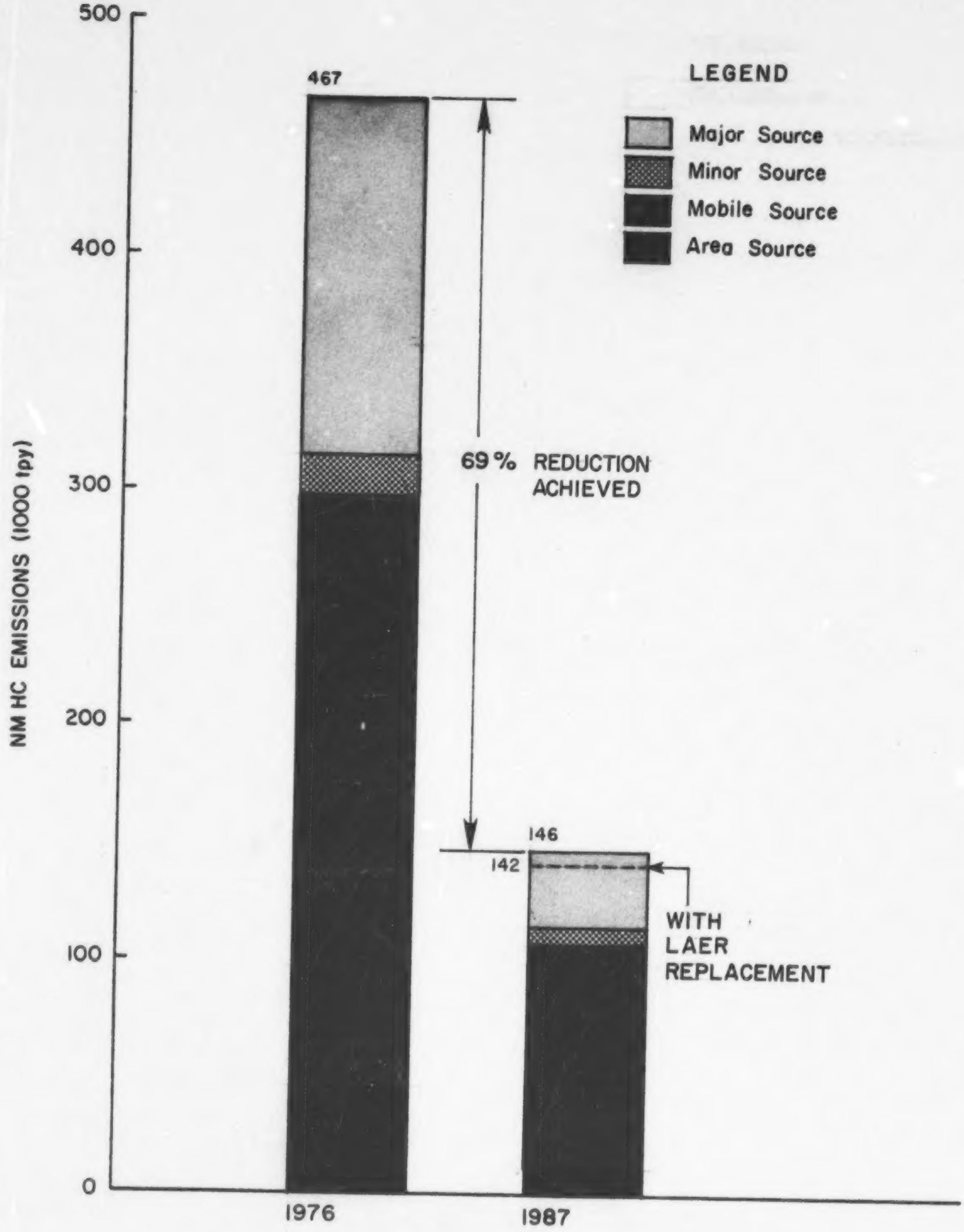
Figure VI-2 is a bar graph comparing emission levels in the base year (1976) with those realized by 1987 under the RACT SIP. From an initial emission level of about 467,000 tpy, a final level of about 146,000 tpy was reached. This reflects a 69% reduction. The final level is smaller than the two estimates of the level needed to attain, 233,256 and 158,614 tpy, using modified rollback and EKMA with no consideration of transport, respectively. For EKMA with consideration of transport, the emissions reduction realized from this scenario is just sufficient for attainment in 1987. The graph shows clearly the three sources of reduction.

VI-2

FIGURE VI-2

II:

RACT SIP
WITH MAJOR SOURCE CONSTRUCTION



When the effect of LAER replacement of retired facilities is considered at the guideline rate, it is seen to have a relatively small impact, reducing emissions from 146,000 to 142,000 tpy or less than 3%. This is less significant than in the previous example because here the LAER improvement is compared to RACT levels, not pre-1979 SIP levels. The total emissions reductions assuming LAER replacement are below both estimates (modified rollback and EKMA) of the NMHC emission reduction needed to attain the 0.12 ppm ozone standard in 1987.

III: RACT SIP With Emission Offsets

This policy option differs from the RACT SIP option in one detail only: major point sources, those with the potential to emit more than 100 tpy, must obtain offsetting emissions from existing sources before they can be permitted to build or expand existing sources in actual emission increments of 50 tpy. The offsets affect a slight reduction for each qualifying major source construction. This has proved to be a minor detail for the Philadelphia AQCR because the growth rate was projected to continue to be small. For this same reason and also because of the great abundance of offsets, at least prior to the promulgation of the RACT SIP revisions, growth was not curtailed throughout the study period because of this requirement.

Figure VI-3 is a bar graph comparing base year emission levels with those attained by 1987 under the emission offset policy. The emission total of about 146,000 tpy for the 1:1 offset ratio, was a 69% reduction as in the case of the RACT SIP.

The emission reduction achieved by 1:1 offsets was 1,637 tpy, but 892 tpy were pre-1979 SIP-RACT offsets, which were reductions also achieved by the RACT SIP. Only the 745 tpy RACT-LAER offsets resulted in lower emission levels than the RACT SIP by 1987. The 3:1 offset ratio produced a reduction of just about 1,500 tpy additionally. Again, the pre-1979 SIP-RACT emission offsets taken early before the adoption of the RACT SIP revisions, effect no real reduction by 1987. Only the RACT-LAER offsets achieve the 1,500 tpy additional reduction over the 1:1 offset ratio.

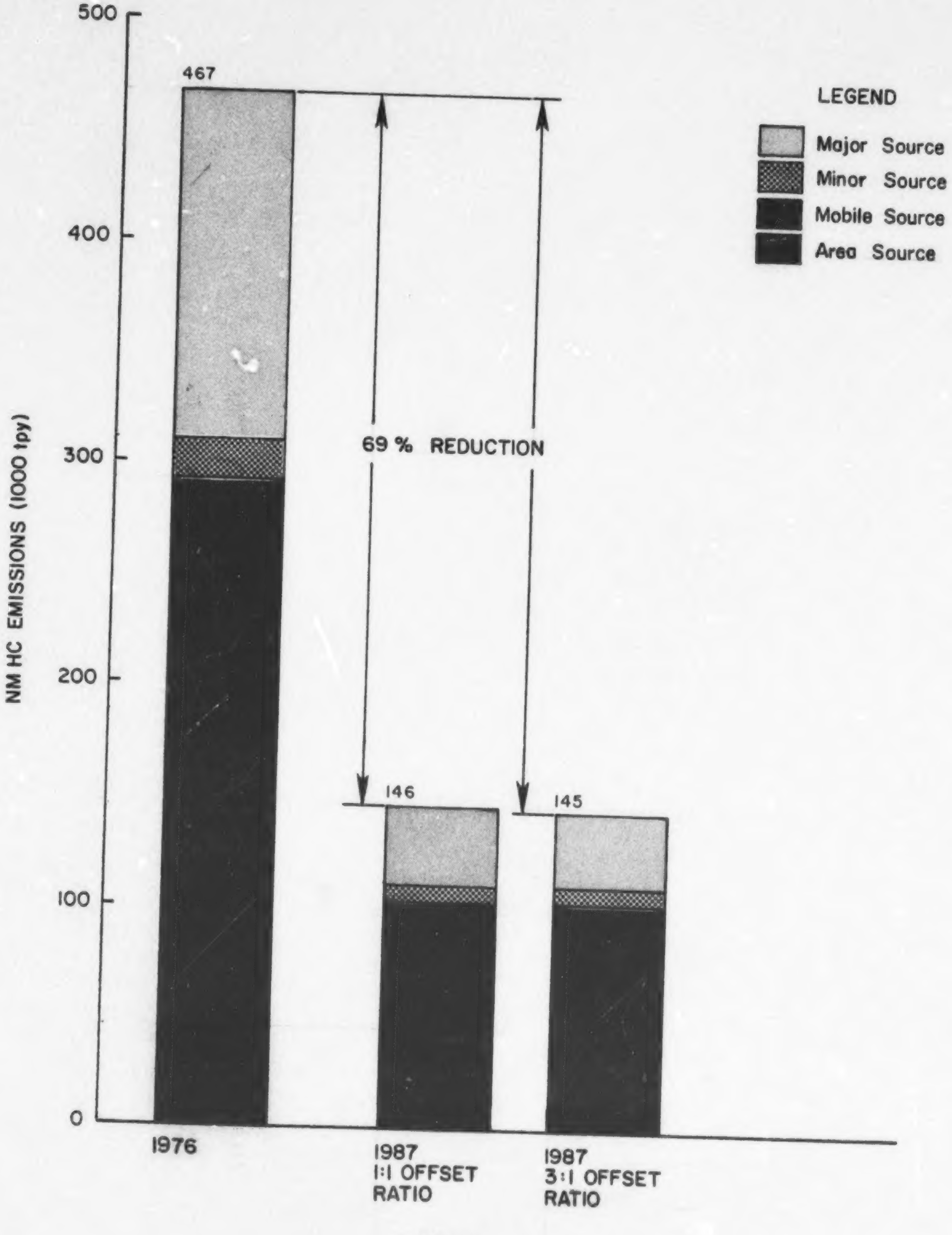
The emission levels achieved are below both the modified rollback and EKMA (with no consideration of transport) estimates of the level needed to attain the 0.12 ozone standard. However, the level achieved is right at the EKMA (with transport) estimate of the level needed.

VI-3

FIGURE VI-3

III:

RACT SIP
WITH MAJOR SOURCE CONSTRUCTION
WITH OFFSETS



IV: RACT SIP With No Major Source Construction After 1979

Again, because the projected growth rate for the Philadelphia AQCR is so small, the effect of prohibiting growth of major sources was small. The emission total in 1987, about 144,000 tpy, is still just a 69% reduction from the base year total. This additional reduction, on the order of 2-3,000 tpy, comes entirely from the prohibition of major source growth. Minor point sources, area sources, and mobile sources have the same 1987 levels as in the previous scenarios. The LAER replacement of retired facilities at the guideline rate produces a total of about 140,000 tpy, another 4,000 tpy reduction. Again, the emission level was attaining for two estimates of necessary reduction and equivalent to the third estimate (EKMA with transport).

V: LAER Replacement With No Major Source Construction After 1979

This was the most restrictive of the options considered. It produced emission reductions beyond those achieved by the RACT SIP option in three ways:

- It required total replacement of existing point sources, or retrofit with LAER control technology, instead of replacement at the guideline retirement rate.[1]
- It required more stringent controls (RACT-2) on area sources.
- It required a 20% reduction in projected vehicle miles traveled through transportation control planning.

The emission level achieved in 1987 under this scenario was about 135,000 tpy. This was a 71% reduction from the base year emission level of 467,000 tpy. It was just a 7-1/2% reduction from the RACT SIP option and was below both estimates (modified rollback and EKMA) of the level needed to attain the 0.12 ppm ozone standard.

Potential for Attaining Standard

Bar graphs showing the direct comparison of the five future scenario studies are presented in Figure VI-4. The associated emissions are presented in Table VI-1. They show clearly that some action must be taken to attain the 0.12 ppm ozone standard; that the RACT SIP represents a significant reduction that attains by modified rollback and EKMA (with no transport) estimates and equals the EKMA

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[1] Assuming that the LAER replacement would all take place between 1980 and 1990.

FIGURE VI-4

POTENTIAL TO ATTAIN THE OZONE STANDARD

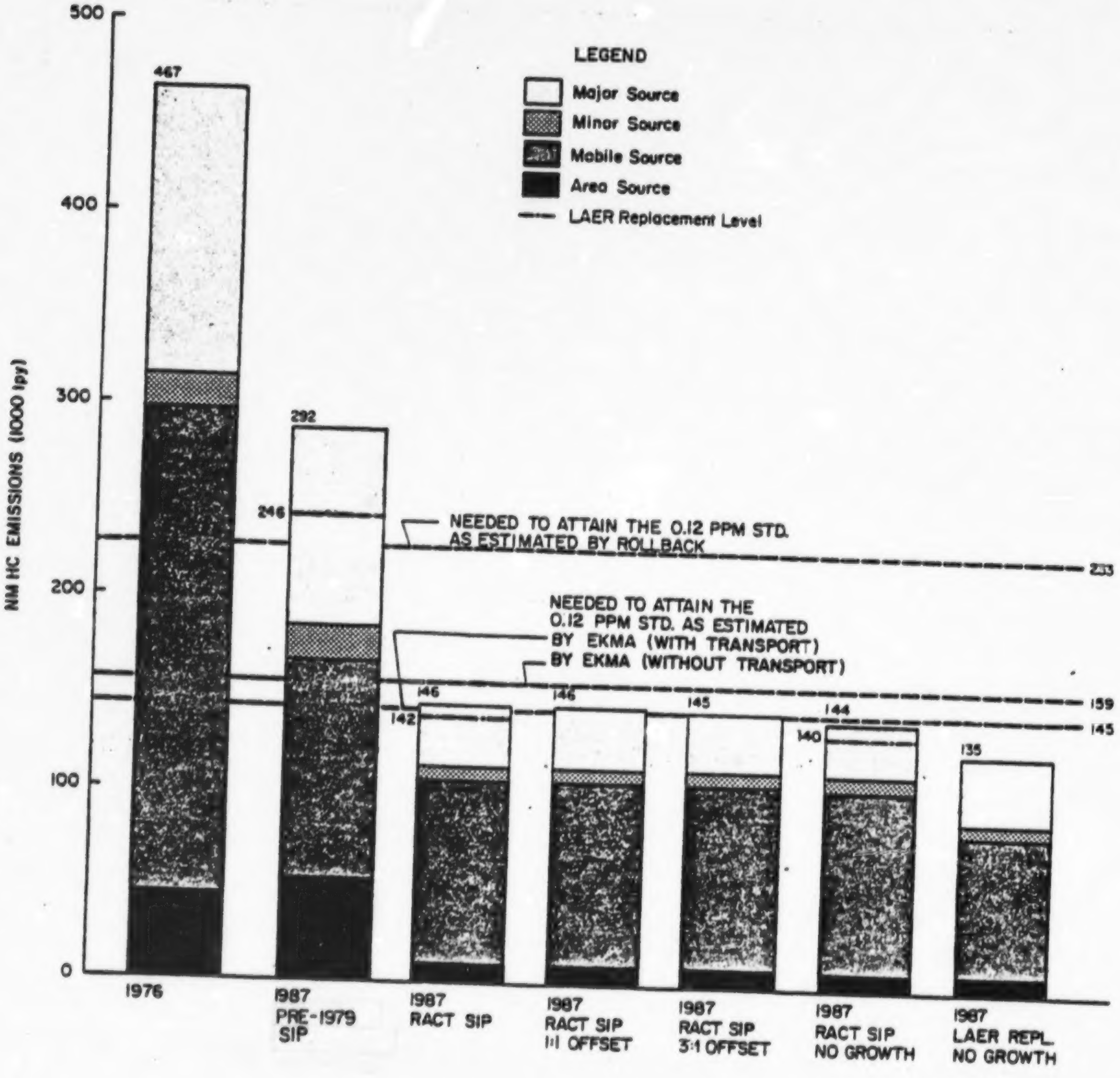

TABLE VI-1

COMPARISON OF 1987 NMHC EMISSIONS FOR VARIOUS POLICY OPTIONS
(TONS/YEAR)

		MAJOR SOURCES					
SCENARIOS	TOTAL EMISSIONS	SUBTOTAL	EXISTING AT SIP	REPLACEMENT OR RETROFIT AT LAER	NEW AT LAER	MOBILE SOURCES	AREA/MINOR SOURCES
1976 Emissions Inventory Used in This Study	466,513	152,001	101,752[a]	N/A	N/A	252,410	62,105
1987 Emissions							
Base Case: Pre-1979 SIP with Major Source Construction with							
Replacement at	292,359	104,605	101,752	N/A	2,853	117,329	70,425
LAER	246,054	58,300	40,637	14,810	2,853	117,329	70,425
RACT SIP with Major Source Construction							
with Replacement at	146,709	31,809	28,956	N/A	2,853	97,229	17,671
LAER	142,584	27,684	10,021	14,810	2,853	97,229	17,671
RACT SIP with Offsets for Major Source Construction							
1:1	145,967	31,067	28,214	742	2,853	97,229	17,671
3:1	144,483	29,583	26,730	2,226	2,853	97,229	17,671
RACT SIP with No Major Source Construction							
after 1979	144,376	29,476	28,956	N/A	520	97,229	17,671
with Replacement at LAER	140,251	25,351	10,021	14,810	520	97,229	17,671
LAER Replacement with No Major Source Construction[b]	135,261	38,578	25,438	12,620	520	82,343	14,340

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[a] 50,249 tpy will come into compliance with pre-1979 SIP in 1978.

[b] Assumes complete replacement by 1990.

(with transport) estimate; that the Philadelphia AQCR is relatively insensitive to other, more restrictive options, yielding only 7-1/2% additional reduction over the RACT SIP in the most restrictive case considered.

SENSITIVITY ANALYSES

The effect of varying key parameters was tested and the results are presented below.

Base Year Emission Inventory

The dominant component of the emission inventory was the mobile sources, particularly highway vehicles. However, this may be the least reliable of all of the source emissions estimates because of the many parameters for which regional specific data were not available (e.g., vehicle mix by road class) and because of the broad categorization (e.g., only two road classifications) that was necessary. The effect of being in error by 20% in that component was tested using Policy Option III.

An overestimate would mean that the mobile emissions were really 200,000 tpy instead of about 250,000 tpy. All sources would have totalled 414,106 tpy. The emission level required to attain by 1987 using modified rollback would have been 207,053 tpy. The EKMA requirement with and without consideration of transport would have dropped to 128,373 and 140,796 tpy, respectively. The mobile component would have been 78,000 tpy in 1987 and the total would have been about 127,000 tpy. This is below both the modified rollback and EKMA estimate of the reduction necessary for attainment.

An underestimate would mean that the mobile emissions were really 300,000 tpy. All sources would have totalled 514,106 tpy. The emission level required to attain by 1987 using modified rollback would have been 257,053 tpy. The EKMA requirement with and without consideration of transport would then be 159,373 and 174,796 tpy, respectively. By 1987, the mobile component would have reached about 117,000 tpy and the total would have been about 165,000 tpy. This is well below both the EKMA (without transport) and the modified rollback estimates. It is above the EKMA (with transport) estimate.

An overestimate of the mobile source emissions in the base year does not vary the basic outcome reported previously for Policy Option III. However, an underestimate results in emissions in excess of the EKMA (with transport) emissions goal for attainment.

Ozone Design Value

Perhaps the most critical parameter used in this study, since it uniquely determines the reduction in emissions required to attain the standard, is the ozone (O_3) design level. It must be assumed that there is a true value and a variety of ways to estimate it. Instead of the way selected, the fourth highest valid reading at the highest monitor with records extending over the past three years, the highest second high reading in the base year could have been used. This value is given in Table A-1 as 0.329 ppm. The study would have had somewhat different results.

The primary effect is on the calculation of the percent reduction needed to attain the 0.12 ppm standard. The EKMA calculation, using an additivity of 0.5, an initial or precontrol transport of 0.075, and a postcontrol transport of 0.06 yields 72% reduction needed to attain instead of 69%. The modified rollback calculation yields 58% instead of 50%. Since only the most stringent option yields a reduction of 71%, LAER replacement with no major source growth, the potential for attainment might be possible using the EKMA procedure with transport consideration. Of course, the least stringent option achieved a 69% reduction, and it might be argued that this was close enough. However, it must be remembered that modified rollback provides the smaller estimate of the required reduction. For a good potential to attain, reductions well below the rollback value should be planned for.

It should be pointed out that there is little likelihood that the O_3 design value has been overestimated. In that unlikely event, however, the least stringent positive action considered in this study, the RACT SIP, would probably suffice to attain even the EKMA level.

Growth

In Appendix D, the range of estimates of expected growth by industrial category is given. An intermediate value had been selected in every category for the study presented here. These growth rates represented government projections, such as Obers, and the opinion of local industrialists. To test the sensitivity of the results of this study to growth, the extreme high and low values of the growth rates were considered.

The point source growth was considered by industrial source category and by minor and major source classification. The major source growth was again grouped into growth in greater than 50 tpy increments and growth in less than

50 tpy increments. In the high growth scenario, the growth by 1990 in amounts greater than 50 tpy was 3,922 tpy, in amounts less than 50 tpy, it was 2,839 tpy; and in the minor source growth category, the growth was 2,543 tpy. These compare with the figures used in the study: 2,080, 1,549, and 1,648 tpy, respectively. In the low growth scenario there were shutdowns in iron and steel production, surface coating, and printing presses. The net growth was actually a reduction: -265 tpy for major source growth increments greater than 50 tpy; -328 tpy for increments less than 50 tpy; and -344 tpy for minor source growth.

The RACT SIP with 1:1 offsets was used to compare the 1987 emission levels with these growth levels to that presented earlier. In this policy option, area sources are controlled at RACT, the mobile sources are controlled by the FMVCP and a strong I/M program, the RACT SIP has been promulgated for existing sources, and offsetting emissions are required for new major source growth in increments greater than 50 tpy. In the high growth case, there were sufficient offsets so that growth was never curtailed. The total emission level in 1987 was 148,474 tpy. In the low growth case, the total emission level in 1987 was 142,307 tpy.

The reduction achieved in the high growth scenario is 68%; in the low growth, 69%. These levels fall on both sides of the EKMA (with consideration of transport) estimate of the emission level needed to attain. The level reached in the case considered in the study was 145,969 tpy. Clearly, a high growth rate for the Philadelphia AQCR may provide sufficient additional emissions to prevent attainment while a low growth rate may facilitate attainment.

Growth Schedules

Growth was assumed to take place in uniform annual increments in the basic study. Particularly in the offset policy option, it was noted that RACT offsets were simply an early conversion to RACT technology which permitted growth but lowered the effectiveness of the RACT SIP when it was promulgated. The effect of pulsing the growth, or having it all occur very early or very late in the study was examined.

Only major source growth in increments greater than 50 tpy was considered because only these increments required offsets. Three cases were considered: all growth occurred in 1977, 1982, and 1987; all growth occurred in 1979; and, finally, all growth occurred in 1987. Under the RACT SIP with 1:1 offset ratio, the following emission levels were reached in each of the cases above:

146,463 tpy, 147,157 tpy, and 145,077 tpy, respectively. These differences are insignificant but they illustrate the point made above that offsets before the RACT SIP revision reduce its effectiveness while offsets after the SIP revision do not.

Control Technology

Definitions were made for RACT and LAER controls for the purpose of this study. They are presented in Appendix C along with the underlying rationale. They were held fixed, however, for the entire 14-year study period, and this is most unlikely. Improvements in control technology since 1970 have been impressive. Continued improvement at a slower rate seems likely.

To test the effect of improving control technology, it was simply assumed that RACT controls in the mid-eighties would produce the emission rates of the LAER technology defined in this study. In this event, the RACT SIP would become, in effect, the LAER SIP, and the total emissions would be reduced in 1987 by 11/14 of the 15,391 tpy difference between the RACT and LAER point source total. The total emissions by 1987 would then be 133,876 tpy instead of the 145,969 tpy RACT SIP value calculated with unchanging technology. This emission level is well below the two estimates (modified rollback and EKMA) of the level needed to attain the 0.12 ppm standard.

On the other hand, should the implementation of controls dictated by the initial control technology guidelines (CTG) be delayed (see Table C-1 for schedule), the RFP requirement may not be realized. To test the sensitivity of such delays on meeting RFP in 1982, it was assumed that all CTG sources with pre-1983 compliance dates were not in compliance until 1983. Such a delay would increase emissions by about 29,000 tpy in 1982 to 285,000 tpy. However, the RACT SIP with major source construction policy option would still provide sufficient emissions reduction to meet the RFP requirement for all emission reduction procedures considered.

Other Ozone Standards

Following much study in 1978, a new standard of 0.12 ppm was established for ozone (the principle component of oxidants). This new National Ambient Air Quality Standard (NAAQS), which protects both the public health and welfare, is for a one-hour average period and is not to be exceeded more than once per year. The main thrust of this report addresses the potential for attainment of the new 0.12 ppm ozone standard; however, prior to establishing the new NAAQS, the standard for oxidants was 0.08 ppm, one-hour average. In addition, consideration was given to a new standard of 0.10 ppm during the 1978 study phase. Because of the uncertainty surrounding the level of the standard during preparation of this report, sensitivity analyses were completed assuming the NAAQS set at 0.08 and 0.10 ppm.

If the ozone standard were held at 0.08 ppm, the required reduction to attain would be 73% as estimated by rollback and 86% as estimated by EKMA. These amount to 125,959 tpy and 65,312 tpy, respectively. No option considered achieved a reduction as great as rollback, the least demanding estimate. If the ozone standard were raised to 0.10 ppm, the required reduction to attain would be 61% as estimated by rollback and 78% as estimated by EKMA. These amount to 181,940 and 102,633 tpy. Every policy option, except RACT SIP, considered in this study achieved reductions well below the modified rollback estimate while none of the options achieved reductions below the most conservative estimate, EKMA.

APPENDIX A

OZONE DESIGN VALUE FOR PHILADELPHIA

The formation of ozone (O_3) from a complex mixture of hydrocarbons (HC) and nitrogen oxides (NO_x) in the presence of sunlight is not well understood. It is clear that the old Appendix J method[1] was too simplistic in that it assumed no background O_3 or HC concentration. Both are known to be important, although natural HC emissions (such as terpenes) may be truly insignificant. Further, not only is the transport of O_3 and HC into an urban area important to the maximum attained in a given day, but also the continued reaction within the plume drifting downwind must be considered. Note again, Figure A-1, that the metropolitan monitors do not record the highest O_3 values. Thus, the problem of determining maximum values attained may require long periods (years) of observations at many locations subject to the area plume. The statistical distribution of extreme values is important as a measure of population exposure. A carefully selected extreme value, the O_3 design value, represents the present exposure and determines the amount of reduction necessary to attain the standard.

Several agencies are responsible for monitoring air quality in the different jurisdictions of the Metropolitan Philadelphia Interstate AQCR. Eleven counties in three states are involved. Data for New Castle County were provided by the Delaware Department of Natural Resources and Environmental Control (DNREC); data for Mercer, Burlington, Camden, Gloucester, and Salem Counties were provided by the New Jersey Department of Environmental Protection (NJDEP); data for Philadelphia County were provided by the Air Management Service (AMS); Philadelphia Department of Public Health; and data for Bucks, Montgomery, Chester, and Delaware Counties were provided by the Commonwealth of Pennsylvania Resources (DER). These agencies use EPA-approved monitoring techniques and provide data to the National Aerometric Data Bank (NADB).

The O_3 monitoring sites maintained by these agencies are shown in Figure A-1. Table A-1 presents a summary of the O_3, nonmethane hydrocarbon (NMHC),

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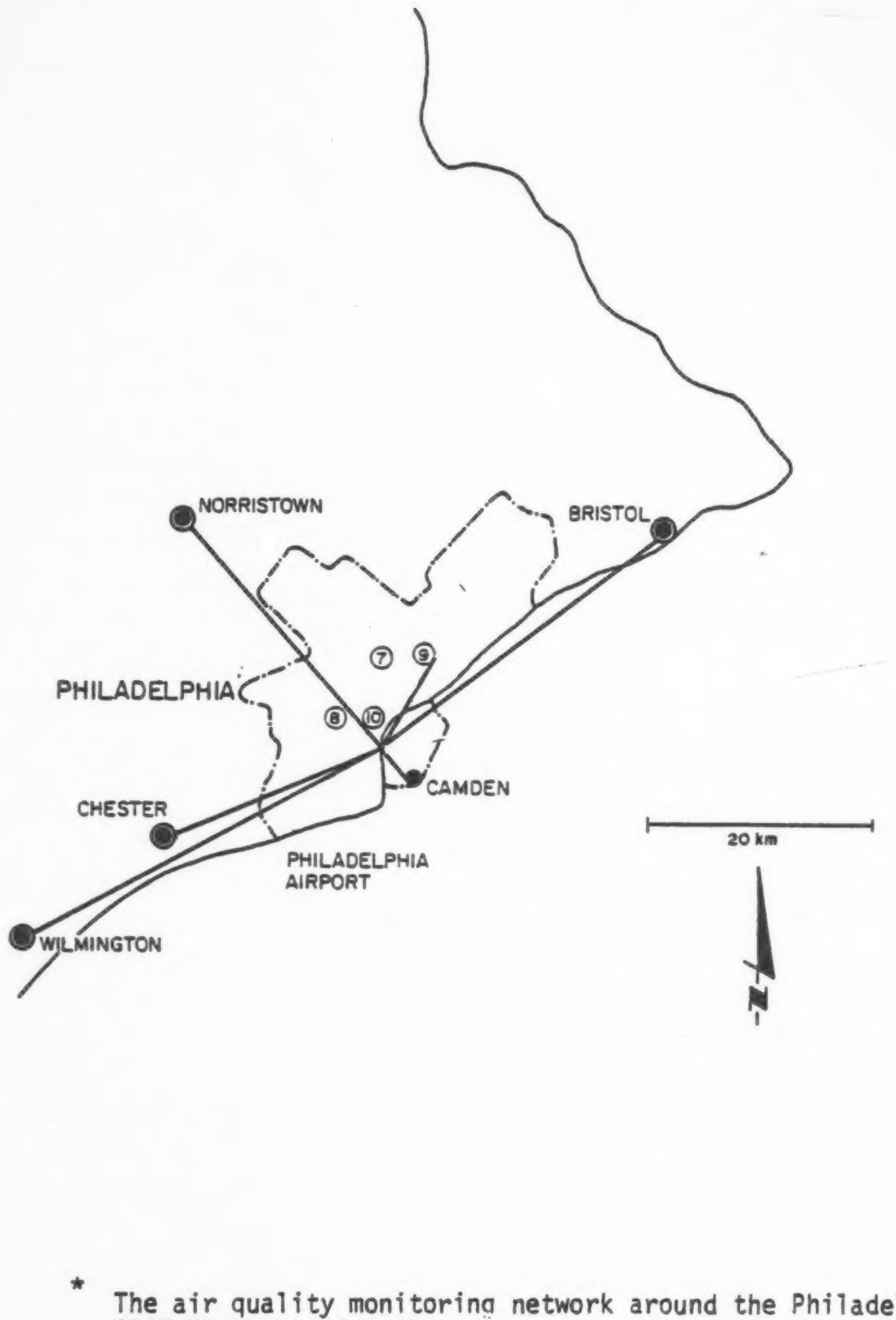
[1] 40 CFR Part 51, Requirements for Preparation, Adoption, and Submittal of Implementation Plans.

AIR QUALITY MONITORING NETWORK *


NORRISTOWN
BRISTOL
PHILADELPHIA
⑦
⑨
⑧
⑩
CAMDEN
CHESTER
PHILADELPHIA AIRPORT
WILMINGTON
20 km
N

* The air quality monitoring network around the Philadelphia AQCR Numbered Sites are urban core sites maintained by Philadelphia AMS.

TABLE A-1

OXIDANT, NMHC, AND NO_x AIR QUALITY DATA FOR 1976
METROPOLITAN PHILADELPHIA INTERSTATE AQCR

	OXIDANTS			NONMETHANE HYDROCARBONS		OXIDES OF NITROGEN	
STATIONS	MAX 1-HR(1) (PPM)	2d HIGHEST (PPM)	% HRS EXCEEDING 0.08 STD.*	HIGH 6-9 AM (PPM)	NO. DAYS (6-9 AM) EXCEEDING 0.24 PPM GUIDE	MAX 1-HR (PPM)	ANNUAL(2) ARITHMETIC MEAN (PPM)
PA							
Bristol	0.216	--	--	--	--	0.078	0.014
Chester	0.233	--	--	--	--	0.124	0.020
Norristown	0.277	--	--	--	--	0.134	0.028
Phila. #1 (DEF)	0.18	--	.01	--	--	---	---
Phila. #2 (ALL)	0.19	--	4.5	--	--	---	---
Phila. #3 (INT)	0.15	--	.64	--	--	---	---
Phila. #5 (ROX)	0.18	--	3.8	--	--	---	---
Phila. #6 (N/E)	0.20	--	4.5	--	--	---	---
Phila. #7 (NBR)	0.15	--	1.2	--	--	---	---
Phila. #8 (FRI)	0.20	--	2.2	3.50	310	---	0.035
Phila. #9 (LAB)	0.17	--	2.5	4.10	282	---	0.043
Phila. #10 (SBR)	0.16	--	1.6	3.73	235	---	0.037
Phila. #11 (S/E)	0.24	--	3.1	--	--	---	0.039

* Calculations reflect former 0.8 ppm standard.

TABLE A-1 (CONTINUED)

OXIDANT, NMHC, AND NO_x AIR QUALITY DATA FOR 1976
METROPOLITAN PHILADELPHIA INTERSTATE AQCR

STATIONS	OXIDANTS			NONMETHANE HYDROCARBONS		OXIDES OF NITROGEN	
	MAX 1-HR(1) (PPM)	2d HIGHEST (PPM)	% HRS EXCEEDING 0.08 STD.	HIGH 6-9 AM (PPM)	NO. DAYS (6-9 AM) EXCEEDING 0.24 PPM GUIDE	MAX 1-HR (PPM)	ANNUAL(2) ARITHMETIC MEAN (PPM)
N.J.							
Ancora	0.166	0.165	5.1	--	--	---	---
Camden Lab.	0.182	0.175	5.6	2.9(3)	279(4)	---	0.034
McQuire AFB	0.205	0.185	4.1	--	--	---	---
Somerville(5)	0.352	0.329	3.0	--	--	---	---
DEL							
P-1 (Woods Haven-Kruse School, Clayton)	---	---	5.2 (Nov. 76)	--	--	---	---
	---	---	0 (Dec. 76)	--	--	---	---
P-2 (Urban Wilmington)	---	---	22.2 (Nov. 76)	--	--	---	---
	---	---	0.4 (Dec. 76)	--	--	---	---

---

(1) NAAQS = 0.08 ppm.

(2) NAAQS = 0.05 ppm.

(3) Total HC measured; NMHC assumed to be 35% of total.

(4) All days for which data are available.

(5) Not in the AQCR but determined by MDAD, OAQPS to be within the region affected by the urban plume.

and NO_x observations made at these locations during calendar year 1976. All sites had observations exceeding the 0.12 ppm National Ambient Air Quality Standard (NAAQS). Norristown had the highest reading within the AQCR, 0.277 ppm. Somerville is not within the AQCR but has been found by EPA's Monitoring and Data Analysis Division (MDAD) to be frequently within the Philadelphia plume. It was in the plume on the day the hourly values of 0.352 ppm and 0.329 ppm were made. The highest reading in 1975 was 0.327 at Bristol. The HC guide for controlling O_3, 0.124 ppm average between 6-9:00 AM, was exceeded at all sites monitoring HC; the NO_x NAAQS, however, was not exceeded.

The O_3 design value for the Philadelphia AQCR was determined by MDAD in consultation with the monitoring agencies in the area. Careful review of technical aspects, such as calibration records, was necessary before the statistical distribution of extreme values within the plume could be established. The value determined to be the O_3 design value for the Philadelphia AQCR was 0.22 ppm. This was the fourth highest valid reading at Somerville in the past three years of continuous monitoring and an acceptable estimate of the expected second highest value to be experienced in the plume in any given year.

APPENDIX B

METHODOLOGY AND ASSUMPTIONS FOR CALCULATING EMISSION REDUCTIONS

Ozone formation depends upon the ambient levels of hydrocarbons. These ambient levels are determined by the hydrocarbon emissions in the area. Reduction in these emissions is achieved by the more stringent control technology required by the amendments of 1977. RACT and LAER represent control levels which usually must be specified for each process in each plant; however, more general definitions have been established for the purposes of this study which may be applied to all plants with a common process. These definitions are presented in Appendix C. We are concerned here with the method of applying them to the base year point source emission inventory in order to detrmine the new or resulting emission level. The ensuing discussion describes the methodology which was used for calculating the emissions for the RACT and LAER emission control scenarios. Emissions are of primary importance of this study.

METHODOLOGY AND ASSUMPTIONS

Three basic inputs are required in order to calculate emissions using the RACT and LAER definitions of Appendix C:

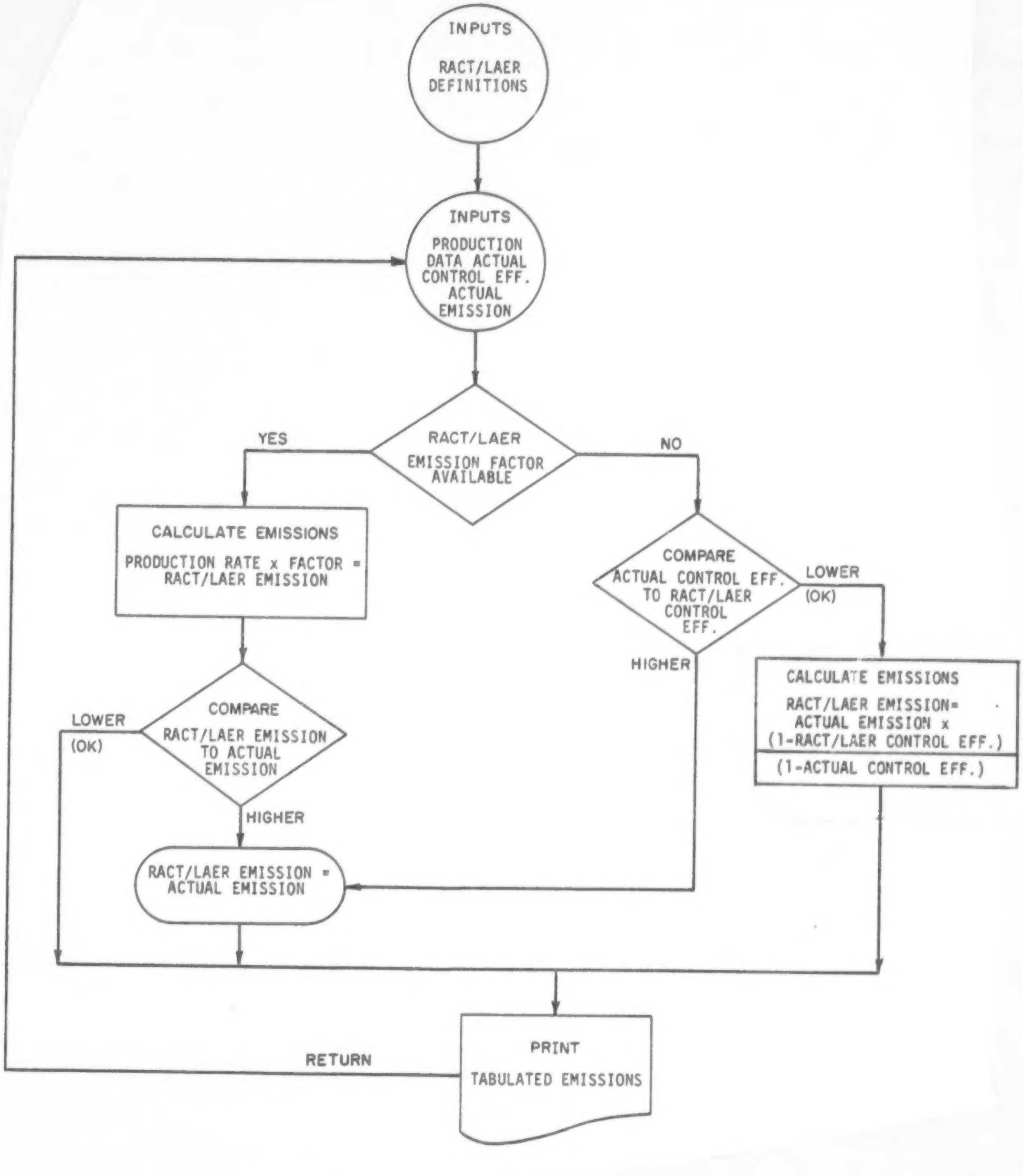
- production data by process;
- RACT/LAER emission factors and/or control efficiencies; and
- actual 1976 emissions and/or control efficiencies.

Production data were in general available except when confidentiality was claimed. This was always respected. The emission control definitions for RACT and LAER are presented in Appendix C of this report. These factors are organized by source classification codes (SCC) which correspond to individual industrial processes. The actual emissions were the emissions tabulated in Appendix E. Thus, the necessary input was generally available.

Figure B-1 illustrates the calculation methodology used to determine HC reductions for this analysis. The three data fields described above were the basic inputs. If a factor was available, calculations to estimate emissions were made by taking the production rate (activity level) for each individual process and multiplying this quantity by the appropriate RACT/LAER emission factor. There were instances where the actual emissions were lower than those

FIGURE B-1

EMISSION CALCULATION METHODOLOGY (RACT/LAER) FOR PHILADELPHIA AQCR


INPUTS
RACT/LAER DEFINITIONS
INPUTS
PRODUCTION DATA ACTUAL CONTROL EFF. ACTUAL EMISSION
RACT/LAER EMISSION FACTOR AVAILABLE
YES
NO
CALCULATE EMISSIONS
PRODUCTION RATE x FACTOR = RACT/LAER EMISSION
COMPARE ACTUAL CONTROL EFF. TO RACT/LAER CONTROL EFF.
LOWER (OK)
HIGHER
CALCULATE EMISSIONS
RACT/LAER EMISSION= ACTUAL EMISSION x (1-RACT/LAER CONTROL EFF.) / (1-ACTUAL CONTROL EFF.)
COMPARE RACT/LAER EMISSION TO ACTUAL EMISSION
LOWER (OK)
HIGHER
RACT/LAER EMISSION = ACTUAL EMISSION
PRINT TABULATED EMISSIONS
RETURN

which were calculated for RACT or LAER emissions. In all cases, a comparison of the calculated RACT/LAER emissions with the actual emissions for that process was made. The lower of these two emission values was then summed for all processes in the AQCR.

In those cases where a RACT or LAER emission factor was not available, other assumptions were made. If there were no LAER emission factors, but a factor did exist for RACT, the RACT factor was used for the LAER calculation. This was the case for 12.5% of the total point source emissions in the Philadelphia HC inventory. There were several occasions when the control technology using LAER was available, but nothing was found for RACT (reflecting about 1% of the total point source emissions). In these instances, no substitution of the control technology definitions was made. Obviously, LAER control technology could not be used to calculate RACT.

In the event that neither a RACT nor a LAER emission factor was available, the RACT/LAER control efficiency was used. If the RACT/LAER control efficiency was lower than the actual control efficiency, the RACT/LAER emissions were calculated as the product of the actual emissions and the ratio of one minus the RACT/LAER control efficiency to one minus the actual control efficiency. On the other hand, if RACT/LAER control efficiencies were higher than actual control efficiency, then the RACT/LAER emissions were set to the actual emissions.

A computer program was devised to facilitate the handling of the large volume of data associated with calculating emissions under these different circumstances. The calculations were made for each process within a plant, for each plant within the AQCR, and then summed over the entire AQCR.

SAMPLE CALCULATION

Phthalic anhydride was produced in the amount of 43,680 tons/year at an uncontrolled plant. AP-42, Compilation of Air Pollutant Emission Factors, gives an uncontrolled emission factor of 32 pounds per ton produced. The SCC for this process is 3-01-019-03 and reference to the control definitions in Appendix C shows a RACT control efficiency of 90-95%, using an afterburner, and 99% using a wet scrubber. The actual emissions were (43,680 x 32) ÷ 2,000 = 700 tons/year. Using the lower value in the RACT range, RACT emissions were 700 x 0.1 = 70 tons/year; LAER emissions were 700 x 0.01 = 7 tons/year.

APPENDIX C

EMISSION CONTROL DEFINITIONS

In investigating the effect of various policy options in the attainment of ozone standard in the Philadelphia AQCR, the control technologies that could be applied to new and existing stationary sources had to be identified. It was the purpose of this study to test the AQCR-wide effects of various policy options. Hence, it was not appropriate to conduct a detailed examination of the emission characteristics of each plant as probably would be necessary for revision of the State Implementation Plan (SIP). A generalized approach that addressed identical emission processes/sources in the AQCR uniformly as a group was used. This approach incorporated the best judgment of the emission factors and corresponding control technologies to estimate future emission levels.

BACKGROUND

Emission Factor Concept

An emission factor relates the quantity of pollutants emitted to some activity indicator such as production, capacity, or quantity of fuel burned. The factor normally corresponds to a specific type of activity but is, in most cases, based on statistical or estimated averages for a specific process. As such, the factor does not permit one to estimate emissions accurately from an individual installation but is acceptable when applied to a large number of similar processes, as was done for this analysis. The emission factor concept is ideally suited to this study because AQCR inventories were developed as part of an area-wide policy option study.

While emission factors have reached a sophisticated level for particulate sources, such is not the case for many hydrocarbon sources. This is especially true for the petrochemical industry. Particulate sources tend to have "standardized" equipment that does not vary much from plant to plant. Control technology is also quite standard. Baghouses, for example, are used in many different industries to control particulate emissions. For manufacture of a given petrochemical, however, several entirely different processes may be used. Petrochemical plants are often custom-designed for a particular location. As a result, variability exists from plant to plant even though identical process types are employed to manufacture the same chemical. Control methods are usually associated with some type of process modification that can also vary from plant to plant for the same process. Consequently, for petrochemical manufacturing, emissions may not be proportional to production making the development of an emission factor very difficult. As will be discussed later, some problems were encountered in applying the hydrocarbon emission factor concept to the petrochemical industry.

Sources of Information

Engineering-Science did not conduct original research in developing control technology definitions. Such a task would require a substantial manpower effort, an effort of much greater magnitude than that anticipated for this study. In this analysis, control technology definitions already developed from other research efforts were used. The data deficiencies found to exist after the evaluation of available information were corrected with the aid of EPA's Emission Standards and Engineering Division (ESED). A parallel investigation was conducted by another EPA contractor for the Chicago AQCR. The EPA Project Officer reviewed both sets of technologies for the purpose of standardization of definitions for identical processes.

The types of control technology references used consisted of documents prepared by EPA's Office of Air Quality Planning and Standards, Emissions Standards and Engineering Division (ESED) and several prepared by contractors for various EPA offices and divisions. The ESED publications were Control Technique Guidelines (CTG) or standard support documents for miscellaneous refinery sources, various sources of volatile organic compounds, solvent metal cleaning operations, surface coating, tank truck gasoline loading terminals, and vinyl chloride manufacturing. The EPA document, Compilation of Air Emission Factors (AP-42), provided control technology data for a wide variety of air pollution sources. Reports from the EPA contractors--Radian Corporation, The Research Corporation of New England, Pacific Environmental Services, PEDCO Environmental, and the Houdry Division of Air Products and Chemicals--provided information for a wide range of processes, including the petrochemical, petroleum, and iron and steel industries.

The Houdry surveys were the main data references used for processes associated with the petrochemical industry. The survey reports provided both controlled emission factors (weighted average based on production rate) and typical control efficiencies. The typical control efficiency as noted in the Houdry Reports was not necessarily consistent with the controlled emission factor since the factor was a weighted average of all plants surveyed by Houdry. ES chose to adopt the controlled emission factor efficiency (e.g., 99% for flares), primarily because a controlled emission factor was required for study purposes. This methodology provided more realistic estimates of the RACT/LAER emission levels for the purpose of this study in view of the type of process information obtained from the state and local air pollution control agencies.

Engineering-Science also visited the ESED offices to discuss the availability of control technology information for specific processes. Approximately 20 ESED staff members were identified as having expertise in control technology. ES requested assistance from several of the staff members in areas for which control technology information was lacking or inconsistent.

The Project Officer and ESED personnel reviewed the definitions prepared in the previously described manner. The definitions were standardized with those obtained in the Chicago study and missing definitions were provided by ESED. After final review, the Project Officer approved the definitions for use in estimating emissions for the various policy options.

RACT/LAER Definitions[1]

The control technology that is feasible for a new plant may not be acceptable for an existing plant from an economic or technological standpoint. The new plant technology may involve a process modification or other hardware change that would be difficult or impossible to install at an existing plant. An existing plant may not have the space or structural capability to apply new plant technology. Any number of similar circumstances may prohibit the application of the same technology to both new and existing plants.

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[1] An internal EPA Task Force has been formed to determine how best to handle new construction in areas exceeding national standards and how to achieve those standards expeditiously, in a fair and effective manner. A series of studies in addition to this one for the Houston-Galveston area are being conducted to assess the air quality and economic impacts of the current statutory framework and alternative policies. The work of this Task Force should be completed by October 1978. In the interim, ES used the list of emission control assumptions that have been developed for major emission sources. It is important to stress that the control technology assumptions are not regulatory and do not relate to any regulatory program development either national or specific to these regions.

Reasonably Available Control Technology (RACT)

RACT is that level of control of existing stationary source emissions that can reasonably be retrofitted to existing processes, taking technological feasibility and cost into account. By law, it is the level of control that the states will adopt in revised implementation plans in 1979 subject to EPA approval. In some instances, it will provide solely for attainment of standards by December 31, 1982. In others, it will be more stringent at the state's discretion in order to provide an additional margin for growth. In the case of ozone or carbon monoxide, the 1979 RACT SIP revisions may not provide for attainment by 1982. An attainment date extension is permitted until 1987 and the SIP may be submitted in stages with the final submission in 1982.

Clearly, RACT is likely to vary from state to state, from region to region, and even from source to source. This poses a difficult analytical problem in conducting the policy studies. This EPA AQCR study does not take cost into account. We rely upon a range of control assumptions to represent RACT, recognizing that RACT is likely to vary and that certain highly efficient emission control technologies are not readily retrofitted to existing sources where less efficient technologies are currently in use.

Lowest Achievable Emission Rate (LAER)

LAER is defined in the 1977 Amendments to the Clean Air Act as the more stringent of the lowest emission rate achieved in practice or the lowest SIP emission limitation achievable for a class or category of sources. It is currently required of all major new or modified sources requesting permission to construct in nonattainment areas. It will continue to be required by all states in nonattainment areas until national ambient air quality standards are achieved and maintained.

Use of Factors

EPA defines RACT as the lowest feasible emission limit that a source is capable of meeting by the application of economical control technology. The determination of RACT may vary from source to source due to source configuration, retrofit feasibility, operation procedures, raw materials, and other characteristics. For the analysis, such variables could not be considered. As a result, RACT determinations were based on control technologies reported for existing sources and on engineering judgment when control technology found in one of the references was not specifically identified as RACT. The RACT definitions provided herein may not apply to any individual plant because source to source technical and economic characteristics were not considered. EPA is currently in the process of developing generalized RACT guidelines which should be utilized to assist in the definition of RACT for specific plants or sources.

EPA defines LAER as the lowest achievable emission rate, not taking into account economic constraints. In this study, however, no economic factors were considered in defining LAER. When a control technology was not identified in a reference as LAER or Best Available Control Technology (BACT), the technology that allegedly produced the greatest reduction for new sources was adopted. A complicating factor in defining LAER is that it can change rapidly due to new control or process technology. LAER is not an easy term to define for a given time period; the use of current engineering data is essential. ES did not attempt to define LAER in this study and it should be understood that the approach used relied largely on published material some of which was several years old. EPA is conducting studies to coordinate through a central clearinghouse the advances in LAER control technology from all new plants in the United States for future studies.

The RACT and LAER values found in the references took the form of percent reduction of uncontrolled (or partially controlled) emissions or a "controlled" emission factor. If only a percent reduction was provided, a controlled emission factor was, in most cases, calculated by ES by utilizing the percent reduction and the uncontrolled (or partially controlled) emission rate from EPA's Compilation of Air Pollutant Emission Factors, AP-42.

SUMMARY OF CONTROL TECHNOLOGIES

Engineering-Science prepared tables (located at the end of this section) summarizing control technologies for major industrial processes identified in Appendix E of this report. Total emissions from these plants represented about 95% of the AQCR nonmethane hydrocarbon emissions for calendar year 1976 from point sources. For control technology evaluation, all point sources, based on the source classification code (SCC), with significant emissions were selected from these plants.

Each table contains data for a single major industry category as defined by the SCC. The sources within the major categories are arranged in alphabetical order according to process description. The SCC is provided from the current National Emission Data System (NEDS) listing. The process emission units corresponding to the specified emission factors are included in the tables.

Three different emission factors are specified in the tables. The first is the uncontrolled emission factor and, if known, the fugitive portion of the factor. The remainder of the table is devoted to RACT and LAER definitions. For each technology, the applicable abatement method, corresponding controlled emission factor, and data references are specified. It should be mentioned that the "range of control" and the "uncontrolled emission factor" for the chemical manufacturing industry are not, in all cases, consistent with the "controlled emission factor". This is because a given process may have several emission points associated with it, not all of which are to be controlled with the specified abatement method.

In addition, the controlled emission factors obtained from the Houdry surveys represent the average (weighted for production rate) of the plants that responded. In the survey reports, there was no attempt to provide the controlled emission factor corresponding to the control efficiency specified by Houdry. Because the controlled emission factor was an average value while the specified efficiency was not, the two values were not consistent and would not result in the same emission level. For estimating emissions, ES chose to use the controlled emission factor reported by Houdry rather than the efficiency. It was not felt that there was sufficient data or justification to attempt to develop an (averaged) uncontrolled factor which could be used with the control efficiency to estimate the controlled emission factor.

A summary of the control technologies used in our analysis is shown in Table C-2.

TIMING FOR ISSUANCE, ADOPTION, AND IMPLEMENTATION OF EMISSION CONTROL TECHNOLOGIES

Presently, there is little published information of RACT and LAER controls for major hydrocarbon emission sources. As a result, EPA is in the process of reviewing these source categories and in the future will be publishing guidelines on controls for volatile organic compounds. Because not all of the control technologies for hydrocarbons are known at this time, the schedule of when these technologies would become available (and as a result be incorporated into the implementation plan) is of major importance to this study. As long as the control technology is not specified as an emission regulation in the SIP, those source categories can be credited as offsets, thus allowing more growth to occur in a specific area.

The EPA will be issuing guidelines over the next two or three years which will cover all hydrocarbon emissions sources. Table C-1 shows the schedule of when the guideline documents will be issued, when they are expected to be incorporated as part of the SIP, and when attainment with the new SIP is expected. The latest document is scheduled to be issued in June 1979. The expected attainment for all of the hydrocarbon sources is December 1985.

In Table C-1 under the Guidance Issued column, the check marks refer to those documents which have already been issued by EPA and which are expected to be included as part of the January 1979 SIP submittal.

TABLE C-1

SCHEDULE FOR ISSUANCE, ADOPTION, AND IMPLEMENTATION OF GUIDELINES FOR SOURCES OF VOLATILE ORGANIC COMPOUNDS

	Guidance Issued[1]	SIP Revision Date	Attainment Date[2]
Gasoline & Crude Oil Storage	✓Dec. 1977	June 1979	Dec. 1981
Gasoline Marketing			
Service stations-Stage 1	✓ Issued	June 1979	Dec. 1981
Bulk terminals	✓Oct. 1977	June 1979	Dec. 1981
Bulk Plants	✓Oct. 1977	June 1979	Dec. 1981
Gasoline Marketing			
Service stations-Stage 2	June 1978	Dec. 1979	Dec. 1983
Ship and barge transfer	Dec. 1978	June 1980	Dec. 1983
Petroleum Refining			
Sources	✓Oct. 1977	June 1979	Dec. 1981
Fugitives	June 1978	Dec. 1979	Dec. 1983
Natural Gas & Crude Oil Production	NYS[3]	Dec. 1981	Dec. 1985
Natural Gas & Natural Gasoline Plants	NYS[3]	Dec. 1981	Dec. 1985
Organic Chemical Manufacture			
Process streams & fugitives	Dec. 1978	June 1980	Dec. 1983
Waste disposal & storage and handling	June 1979	Dec. 1980	Dec. 1985
Other Manufacture Pharmaceuticals Paint Manufacture Vegetable Oil Processing	June 1978	Dec. 1979	Dec. 1983
Surface Coating			
Automobiles, Cans, Metal	✓Oct. 1977	June 1979	Dec. 1981
Coils, Paper, Fabric products	✓Oct. 1977	June 1979	Dec. 1981
Metal Furniture, Large Appliances	✓Dec. 1977	June 1979	Dec. 1981
Magnet Wire Insulation	✓Dec. 1977	June 1979	Dec. 1981
Surface coating of Wood furniture			
Other metal products	June 1978	Dec. 1979	Dec. 1983
Plywood and panneling	June 1978	Dec. 1979	Dec. 1983
Architectural & misc. coatings	Dec. 1978	June 1980	Dec. 1983
Wood furniture	Dec. 1978	June 1980	Dec. 1983
Surface coating, industrial finishes, other auto refinishing	NYS[3]	Dec. 1981	Dec. 1985
Adhesives	NYS[3]	Dec. 1981	Dec. 1985
Degreasing	✓ Oct. 1977	June 1979	Dec. 1981
Drycleaning	Dec. 1978	June 1980	Dec. 1983
Cutback Asphalt Paving	✓Dec. 1977	June 1979	Dec. 1981
Rubber Products	June 1978	Dec. 1979	Dec. 1983
Graphic Arts(printing)	June 1978	Dec. 1979	Dec. 1983

1. Walsh, Robert T., Release of Guidelines for Sources of Volatile Organic Compounds. Nov. 22, 1977.
2. Photochemical Oxidant Working Group. (Ken Lloyd principal author) Unpublished implementation schedule of when compliance can be reasonably expected if Guidelines for Sources of VOC are issued on schedule.
3. NYS = Not Yet Scheduled.

TABLE C-2

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY EXTERNAL COMBUSTION BOILER

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Electric Generation - Bit. Coal >100 MMBtu/hr Pulv. Wet & Pulv. Dry	10100201 & 10100202	lb/ton burned	0.30	none	0%	0.3	Ref. 20	Combustion Controls	99.9%	negligible	Ref. 20
Electric Generation - Residual Oil >100 MMBtu/hr Gen.	10100401	lb/10^3 gal. burned	1.0	none	0%	1.0	Ref. 20	Combustion Controls	99.9%	negligible	Ref. 20
Industrial - Residual Oil (and Commercial/ Institutional)	10200401, 10200402, 10300402, & 10300403	lb/10^3 gal. burned	1.0	none	0%	1.0	Ref. 20	Combustion Controls	99.9%	negligible	Ref. 20

DATA REFERENCE:

20. Control Technology Definitions Utilized in Chicago-Gary Non Attainment Study, Argonne National Laboratory, December, 1977.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY INTERNAL COMBUSTION

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Distillate Oil Turbine - Electric Generation & Industrial	20100101 & 20200101	lb/10^3 gal burned	5.57	none	0%	5.57	Ref. 20		99.9%	negligible	Ref. 20

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY CHEMICAL MANUFACTURING

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Acetaldehyde (Ethylene) No Fugitive Reported	30199999	lb/ton produced		Water Scrubbing		18.4	Ref.1, Vol.I, pg. 33				
Acetic Acid (CO Methanol) No Fugitive Reported	30199999	lb/ton produced		Incineration		0.0	Ref.1, Vol.I, pg. 67				
Acetic Acid (Butane) Fugitive not Quantified	30199999	lb/ton produced		Scrubbing and Flaring		76.5	Ref.1, Vol.I, pg. 85				
Acetic Acid (Acetaldehyde) Fugitive Classed As Very Minor	30199999	lb/ton produced		Absorbers and Collection of Pump Seal Losses		19.7	Ref.1, Vol.I, pg. 101				
Acetone	30109101	lb/ton produced									
Acetylene	30199999	lb/ton produced									
Acrylates	30199999	lb/ton produced									
Acrylonitrile (SOHIO)	30199999	lb/ton produced	214-330 (Fug.- 1)	Thermal Incinerator (on absorber vent) and Flare	99.5%	1.0	Ref.2, Vol.2	Thermal Incinerator + Waste Heat Boiler and Flare	99.5%	1.0	Ref. 2 Vol. 2
Alchohol	30199999	lb/ton produced									
Alkylated Liquor	30199999	lb/ton produced									
Ammonia (Methanator) No Fugitive Reported	30100201	lb/ton produced	90.0	Incineration	99%	0.9	Ref. 3				

DATA REFERENCES:

1. Survey Reports on Atmospheric Emissions from the Petrochemical Industry, Volumes 1-IV, Air Products and Chemicals, Inc., Houdry Div., January 1974.
2. Engineering and Cost Study of Air Pollution Control for the Petrochemical Industry, Volumes 1-9, Air Products and Chemicals, Inc., Houdry Div., February, 1975.
3. Controlled and Uncontrolled Emission Rates and Applicable Limitations for Eighty Processes, The Research Corporation of New England, September, 1976.

NOTE: Uncontrolled emission factor for process includes fugitive emission factor if reported.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY CHEMICAL MANUFACTURING (CONT'D)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Butadiene-Synthetic Rubber	30102601	lb/ton produced	40.0	Vapor Recovery/ Recycle	92%	3.1	Ref. 4 & Ref. 1, Vol.IV, Pg. 150				
Caprolactam	30199999	lb/ton produced									
Carbon Black (Furnace-Gas) Fugitive Not Quantified	30100503	lb/ton produced	1800	Flare		10.4	Ref. 2 Vol. 1	Incinerator/ Waste Heat Boiler		0	Ref. 2 Vol. 1
Carbon Black (Furnace-Gas/Oil) Fugitive Not Quantified	30100505	lb/ton produced		Flare		10.4	Ref. 2 Vol. 1	Incinerator/ Waste Heat Boiler		0	Ref. 2 Vol. 1
Cumene	30199999	lb/ton produced									
Cyclohexanone (Cyclohexane) Fugitive Termed Negligible	30199999	lb/ton produced		Recycle/Scrubbing Condenser, Incinerator		78	Ref.1,Vol.II pg. 64	Incineration		11.8	Ref. 20
Ethyl Benzene	30199999	lb/ton produced									
Ethyl Chloride	30199999	lb/ton produced									
Ethylene Dichloride (Oxychlor.)* Fugitive Not Reported	30112501	lb/ton produced	54.6	Thermal Incinerator + Scrubber and Condenser + Flare		0.2	Ref. 2 Vol. 3	Thermal Incinerator + Waste Heat Boiler + Scrubber and Condenser + Incinerator		0.0	Ref. 2 Vol. 3

DATA REFERENCES:

4. Impact of New Source Performance Standards on 1985 National Emissions from Stationary Sources, The Research Corporation of New England, October 1976

* Vinyl chloride monomer emissions not adequately considered.

NOTE: Uncontrolled emission factor for process includes fugitive emission factor if reported.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY CHEMICAL MANUFACTURING (CONT'D)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Ethylene Dichloride (Direct)*	30112502	lb/ton produced	9.7 (Fug.= 1.4)	Condenser + Scrubber		2.3	Ref.1, Vol.II pg. 151				
Ethylene (Pyrolysis)	30199999	lb/ton produced	(Fug.= 0.4)	K.O. Drums, Incinerators, Flares, and Scrubber		1.44	Ref.1, Vol.II pg. 132				
Ethylene Oxide	30199999	lb/ton produced	392.0 (Fug.=				Ref. 2 Vol. 6	Incineration (Thermal or Catalytic)	99%	3.92	Ref. 2 Vol. 6
Formaldehyde (Silver)	30112001	lb/ton produced	(Fug.= 0.5)	Plume Burner or Water Scrubber		2.5	Ref. 2 Vol. 4	Incineration and Recycle		1.8	Ref. 2 Vol. 4
Formaldehyde (Mixed Oxide) Fugitive Not Quantified	30112002	lb/ton produced	18.4	Incineration		2.8	Ref. 2 Vol. 5	Incineration + Recycle		1.0	Ref. 2 Vol. 5
Glycerol (allyl Chloride-Epichlorohydrin) Fugitive not quantified	30199999	lb/ton produced	134.9	Sodium Hydroxide Scrubbers		131.6	Ref.1, Vol.II pg.190,199, 206				
Hydrogen Cyanide (Andrussow) Fugitive Termed Undetectable	30199999	lb/ton produced		Flares and Air Heater (except sample pot vents)		2.5	Ref.1, Vol.II pg. 229				
Maleic Anhydride (Benzene) Fugitive Not Quantified	30110001	lb/ton produced		Condenser, Scrubber, and Boiler/Incinerator		1.7	Ref.1, Vol.III pg. 37				
Nylon 6 (Caprolactam Polymer.) No Fugitive Reported	30102401	lb/ton produced		Condensers, Scrubbers, and Afterburners		0.0 (Caprolactum considered Aerosol -6.4	Ref.1,Vol.III pg. 57				

* Vinyl chloride monomer emissions not adequately considered.

NOTE: Uncontrolled emission factor for process includes fugitive emission factor if reported.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY CHEMICAL MANUFACTURING (CONT'D)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Nylon 6,6 (Nylon Salt Polymer.) Fugitive Not Quantified	30102401	lb/ton produced		Water Scrubbing	99.7% (Finishing Operation)	0.0 (Monomer Considered Aerosol-7.2	Ref.1,Vol.III, pg. 79				
Polyvinyl Chloride (Solvent)	30101801	lb/ton produced	35.6 (Fug.= 0.6)	Vapor Recovery & Lean Oil Scrubber(in series)	85%	5.3 (Fug.=0.6)	Ref. 2, Vol. 9	Absorption/ Adsorption/ Incineration	97%	1.08 (Fug.=0.6)	Ref. 5
Oxoalcohol No Fugitive Reported	30199999	lb/ton produced		Water Scrubbing and Flares		6.1	Ref.1,Vol.III, pg. 101				
Paint No Fugitive Reported	30101401	lb/ton produced	30.0	Thermal/Catalytic Oxidation	95%	1.5	ESED	Same as RACT	95%	1.5	ESED
Phenol (Cumene)	30199999	lb/ton produced	(Fug.= 1.2)	Absorber/ Scrubber/Incin. (with Condensers & K.O. Drums) and Flare		20.6	Ref.1,Vol.III pg. 145				
Polyethylene (High Density)	30101802	lb/ton produced	(Fug.= 40)	Flares (Reactor Section)		68.0	Ref.1,Vol.III pg. 169	Flare stacks/vents Comp. emissions to process imp.,monitoring & maint.		5.0 (Fug = 1.0)	Ref. 21
Polyethylene (Low Density)	30101802	lb/ton produced	(Fug.= 20 Inc. Stg.)	Flares (Purification & Recovery)		32.0	Ref.1,Vol.III pg. 187	Flare stacks/vents Comp. emissions to process imp., monitoring & maint.		2.0 (Fug = 1.0)	Ref. 21
Polypropylene	30101802	lb/ton produced	(Fug.= 30 New Plt.)	Condensers/K.O. Drums & Flares		63.8	Ref.1,Vol.IV, pg. 41	Flare stacks/vents Comp. emissions to process imp., monitoring & maint.		5.0 (Fug = 1:0)	Ref. 21
Polyvinyl Chloride (Suspension)	30101801	lb/ton produced	78.4 (Fug.= 30.5)	Improved Stripping + Vapor Recovery & Lean Oil Scrubber (in series)&Fug.Cont.	80%	15.9 (Fug.= 9.7)	Ref. 2, Vol. 9	Absorption/ Adsorption/Incineration + Fugitive Controls	95+%	3.68 (Fug. = 3.2)	Ref. 5

DATA REFERENCES:

5. Standard Support and Environmental Impact Statement: Emission Standard for Vinyl Chloride, U.S. EPA, Emission Standards and Engineering Division, October, 1975.
21. Based on TACB permit data for new sources. ESED reviewed and approved these factors by assuming technology transfer from similar processes. (Memo from ESED to Ralph Grotelueschen, April 7, 1978.)

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NON-METHANE HYDROCARBONS INDUSTRY CHEMICAL MANUFACTURING (CONT'D)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Polyvinyl Pyrilidon	30110101	lb/ton produced									
Propylene Oxide	30199999	lb/ton produced									
Styrene (Ethyl Benzene)	30199999	lb/ton produced	9.6 (Fug.= 0.3)	Vapor Recovery System and Flares		0.4(est.)	Ref.1,Vol.IV, pgs. 109-117				
Sulfuric Acid (Chamber)	30102201	lb/ton produced	0.0								
Tetraethyl Lead	30199999	lb/ton produced									
Varnish No Fugitive Reported	30101503	lb/ton produced	160.0	Afterburner	95%	8.0	ESED				
Vinyl Acetate (Acetylene) No Fugitive Reported	30199999	lb/ton produced	59.9	Vapor Recovery/ Incineration	Device planned for future. No data available.		Ref.1,Vol.IV, pg. 155				
Vinyl Acetate (Ethylene) No Fugitive Reported	30199999	lb/ton produced		Flare		0.0	Ref.1,Vol.IV, pg. 185				
Vinyl Chloride (Balanced Process)*	30199999	lb/ton produced	9.0 (Fug.= 2.4)	Waste Heat Boilers With Scrubber & Fugitive Controls	90%	0.9	Ref. 2, Vol. 8	Incineration/ Adsorption/ Absorption + Fug. Control	97%	0.28 (Fug.=.24)	Ref. 5
Waste Water Treatment	30199999	lb/ton produced									

* Includes Ethylene Dichloride production

NOTE: Uncontrolled emission factor for process includes fugitive emission factor if reported.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY CHEMICAL MANUFACTURING (CONT'D)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Chlorine - General and Other	30100701 & 30100799	lb/ton produced									
Cleaning Chemicals - Soap/Det. Spry. Dryr.	30100901	lb/ton produced									
Paint Mfg. - Other Mixing	30101499	lb/ton product	(30.0)	Thermal/catalytic oxidation	95%	(1.5)	ESED	Thermal/catalytic oxidation	95%	(1.5)	ESED
Varnish Mfg. - Other Mixing	30101599	lb/ton product		Afterburner	95%		ESED				
Plastics - Phenolic Resins Mfg.	30101899	lb/ton produced	7.5	Flare	95%	0.38	Ref. 3 and ESED				
Phthalic Anhydride	30101903	lb/ton produced		Afterburner	90-95%		Ref. 20	Wet Scrubber	99%		Ref. 21
Printing Inks - Mixers	30102099	lb/ton produced		Scrubber or condenser plus afterburner	90%		Ref. 9 & 3				
Adhesives - General	30105001	lb/ton product			80-99%		Ref.		99%		Ref.
Asbestos Chemical - Sealants	30111102	lb/ton product	0.0								
Trichloroethylene Dryer (Oven)	30199999	lb/ton product									
Petroleum Additives	30199999	lb/ton product									

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY CHEMICAL MANUFACTURING (Continued)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Pharmaceuticals-Coating, Mixing, & Drying	30199999	lb/ton product									
Magnetic Tape Dryer	30199999	lb/ton product									
Pigment Tray Dryer	30199999	lb/ton product									
Synthetic Rubber - Auto Tires General	30102620	lb/ton product		Collection system w/carbon adsorption + incineration/carbon adsorption + use of waterborne materials	89.5-91.3%		Ref. 10	Same as RACT	91.3%		Ref. 10
Sulfonic Acid General and Sulfonates	30111001	lb/ton product									
Formaldehyde (Silver)	30199999	lb/ton product	see	SCC 30112001							
Agricultural Chemical Mfg. Bldg. Vent	30199999	lb/ton product									

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY PRIMARY METALS

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Coke Met. Byproduct - General	30300301	lb/ton coal charged	2.7	Stage charging & scrubber for coal preheater	84%	0.44	Ref. 21	Same as RACT	94%	0.15	Ref. 21

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NON METHANE HYDROCARBONS INDUSTRY PRIMARY METALS

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Coke Oven Fugitive	30300399	lb/ton coal charged	2.5	Stage Charging	86%	0.34	Ref. 21	Stage Charging	98%	0.05	Ref. 16 and Ref. 21
Coke Met. Byproduct-Oven Charging	30300302	lb/ton coal charged	2.5	Stage Charging	86%	0.34	Ref. 21	Stage Charging	98%	0.05	Ref. 21

DATA REFERENCES:

16. "RACT and BACT Definitions Being Utilized in Contract 68-01-4344," Letter to Cheryl Wasserman from Pacific Environmental Services, Inc., February 1977.
21. Emission Factors and Control Technologies for Contract No. 68-01-4325, PEDCo Environmental, Inc., February, 1978

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY MINERAL PRODUCTS

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Asphalt Roofing - Cooling After Saturation	30500199	lb/ton saturated felt produced	(1.0)								

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY PETROLEUM INDUSTRY

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Compressor Seal Fugitive	30600804	lb/10^3 bbl refinery capacity	5.0	Mechanical seals[a] (oil film) or packed glands (for reciprocating comp.)	80%	1.0	Ref. 7	Mechanical seals[a] (oil film) or packed glands (for reciprocating comp.)			Ref. 8
Cooling Tower Fugitive	30600701	lb/10^6 gal cooling water	6.0	Monitoring & maintenance program for heat exchangers	90% (assumed)	0.6	Ref. 6	Monitoring and maintenance program for heat exchangers	90% (assumed)	0.6	Ref. 8
Fluid Cracker	30600201	lb/10^3 bbl fresh feed	220.0	CO boiler and vent relief valves to flare	98%	4.4	Ref. 6	CO boiler and vent relief valves to flare	98%	4.4	Ref. 6
Miscellaneous Plant Fugitive Not Classified	30600805	lb/10^3 refinery capacity	10.0	Conscientious monitoring and maintenance program	90% (assumed)	1.0	Ref. 6	Conscientious monitoring and maintenance program	90% (assumed)	1.0	Ref. 6
Pipe/Valve Flange Fugitive	30600801	lb/10^3 ref. capacity	28.0	Conscientious monitoring and maintenance program	90%	2.5	Ref. 7	Same as RACT	90%	2.5	ESED
Process Drains W/ Control	30600501	lb/10^3 bbl waste water	*8.0	N/A		N/A	N/A	N/A	N/A	N/A	N/A
Process Drains W/O Control	30600502	lb/10^3 bbl waste water	210.0	Seal openings and incorporate liquid traps[a]	96%	8	Ref. 7 & Ref. 9				
Process Heater (Gas)	30600104	lb/10^6 ft^3 burned	30.0	Combustion controls	90%	3	Ref. 6	Combustion controls	90%	3	Ref. 6
Pump Seals Fugitive	30600803	lb/10^3 bbl refinery capacity	17.0	Mechanical seals[a] (oil film) or equivalent-packed glands for reciprocating pump	91%	1.5	Ref. 7	Mechanical seals[a] (oil film) or equivalent-packed glands for reciprocating pump	95%	1.5	Ref. 8 and ESED

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NON-METHANE HYDROCARBONS INDUSTRY PETROLEUM INDUSTRY (CONT'D.)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Vacuum Jets W/O Control	30600602	lb/10^3 bbl vacuum distillation	130.0	Vapor compression and combustion or incineration		Negligible	Ref. 7				
Vessel Relief Valve Fugitive	30600802	lb/10^3 refinery capacity	11.0	Conscientious monitoring and maintenance program	90-95%	1.1	ESED	Ruptyre disc or vent to flare		Negligible	Ref. 8

* Apply monitoring and maintenance program to these sources.

DATA REFERENCES:

6. The Impact of the Clean Air Act on Expansions of Petroleum Refinery, Petroleum Storage, and Selected Petrochemical Feedstock Facilities, (Draft), Volumes I and II, Radian Corporation, March 1977.
7. Control of Hydrocarbons From Miscellaneous Refinery Sources, (Draft), U. S. EPA, Emission Standards and Engineering Division, Chemical and Petroleum Branch, May 1977.
8. Evaluation of Pollution Potential of Proposed Hampton Roads Energy Company Refinery, Portsmouth, Virginia, Pacific Environmental Services, Inc., for U. S. EPA, November 1976.
9. Compilation of Air Pollutant Emission Factors, Supplements 1 through 7, U. S. EPA, AP-42, April, 1977

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY PETROLEUM INDUSTRY (CONT'D)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Process Heater - Oil	30600101	lb/10^3 BBL oil burned	140	Combustion controls	95-99%	7.0	Ref. 20	Combustion controls	99.9%	0.14	Ref. 20
Blowdown System - Without Controls	30600402	lb/10^3 BBL refinery capacity	300	Vapor recovery or flare	98.3%	5.0	AP-42				
Fluid Coking	30699999	lb/BBL processed									
Asphalt Oxidizer General	30601101	lb/ton processed		Afterburner	90-95%		Ref. 20	Afterburner		95%	Ref. 20
Waste Gas Flare	30600999	lb/10^6 ft^3									
Gasoline Terminal Vapor Recovery	30699999	lb/BBL processed		Vapor recovery or incineration	90-99%		Ref. 13,6,63	Same as RACT	99%		Same as RACT

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY LEATHER AND TEXTILE MANUFACTURING

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Finish Coating	32099999	lb/ton processed									
General Fabrics	33000199	lb/ton processed									
Rubberized Fabric - Hot Melt Coating	33000203	lb/ton processed									

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY INDUSTRIAL PROCESS-OTHER/NOT CLASSIFIED

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
PVC Tape Fabrication	39999999	lb/ton processed									

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY POINT SOURCE EVAPORATION - CLEANING SOLVENT

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Degreasing-Misc. Solvents	40100299	lb/ton solvent	1900	Equipment modifications and proper operating procedures	20-70%	1045 (nationwide average)	Ref. 10 & Ref. 11	Same as RACT but additional modifications	70%	798 (Nationwide average)	Ref. 10 Ref. 11
Degreasing-Trichloroethane	40100202	lb/ton solvent	1900	Equipment modifications and proper operating procedures	20-70%	1045 (nationwide average)	Ref. 10 & Ref. 11	Same as RACT but additional modifications	70%	798 (Nationwide average)	Ref. 10 Ref. 11
Surface Wiping	40100399	lb/ton solvent									

DATA REFERENCES:

10. Air Pollution Control Technology Applicable to 26 Sources of Volatile Organic Compounds, U. S. EPA, Emission Standards and Engineering Division, May 1977 (Nationwide average from personal communication with Chemical and Petroleum Branch, July, 1977)

11. Control of Volatile Organic Solvent Metal Cleansing Operations, U.S. EPA, ESED, Chemical and Petroleum Branch, April, 1977.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY POINT SOURCE EVAPORATION

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Cleaning Solvent - Dry-cleaning - Perchloroethylene	40100101	lb/ton clothes cleaned	550	Carbon adsorption and good operating and maintenance practices	81-90%	106	Ref. 9	Same as RACT but better operating and maintenance practices	90%	56	Ref. 9
Surface Coating - Paint Solvent General	40200199	lb/ton solvent in coating	2,000	Carbon adsorption or afterburner	80-95%	400	Ref. 20	Thermal incineration	95%	100	Ref. 20
Surface Coating - Primer General	40200601	lb/ton coating	1,320	Carbon adsorption or afterburner	90%	132	Ref. 20	Thermal incineration	95%	66	Ref. 20
Surface Coating - Adhesive General	40200799	lb/ton solvent in coating	2,000	Carbon adsorption or afterburner	90%	200	Ref. 20	Thermal incineration	95%	100	Ref. 20
Surface Coating - Oven	40200801, 40200802, 40200803,& 40200899	lb/ton coating		Direct flame afterburner	92%		Ref. 20	Direct flame afterburner	99%		Ref. 20
Surface Coating - Solvent	40200901, 40200902, 40200921,& 40200922	lb/ton solvent	2,000	Carbon adsorption or incineration	80-95%	400	Ref. 20	Carbon adsorption or incineration	95%	100	Ref. 20
Surface Coating - Trichlor. Scotchguard on Woven Fabric	40299999	lb/ton coating		Incineration or carbon adsorption	80-95%		Ref. 20	Incineration or carbon adsorption	95%		Ref. 20
Surface Coating - Rubber on Fabric - Spreader Coater	40299999	lb/ton coating		Incineration or carbon adsorption	80-95%		Ref. 20	Incineration or carbon adsorption	95%		Ref. 20
Surface Coating - Printing on Metal Foil and Leaf	40299999	lb/ton coating		Incineration or carbon adsorption	85-90%		Ref. 10	Incineration or carbon adsorption	90%		Ref. 10

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY POINT SOURCE EVAPORATION (CONT'D)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Surface Coating - Solvent Cleaning of Metal	40299999	lb/ton coating		Equipment modifications and proper operating procedures	20-70%		Ref. 10 & Ref. 11	Same as RACT but additional modifications	70%		Ref. 10 & Ref.11
Surface Coating - Lacquer Isopropyl Alcohol and Other	40200404 & 40200499	lb/ton coating	2000	Incineration/Low or No Solvent Coating/Carbon Adsorption/Combination	70-95%	600	Ref. 10 and 15 and ESED	Same as RACT	95%	100	ESED

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBON INDUSTRY POINT SOURCE EVAPORATION - SURFACE COATING

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Enamel - General	40200501	lb/ton coating	840	Incineration/Low or No Solvent Coat./Carbon Adsorption/Combination	80- 95%	168	Ref. 10, Ref. 15 and ESED	(Same as RACT)	95%	42	ESED
Lacquer - General	40200401	lb/ton coating	1540	Incineration/Low or No Solvent Coat./Carbon Adsorption/Combination	70- 95%	462	Ref. 10, Ref. 15 and ESED	(Same as RACT)	95%	77	ESED
Paint - Ethyl Acetate	40200103	lb/ton solvent in coating	2000	Incineration/Low or No Solvent Coat./Carbon Adsorption/Combination	80-95%	400	Ref. 10, Ref. 15 and ESED	(Same as RACT)	95%	100	ESED
Paint - General	40200101	lb/ton coating	1120	Incineration/Low or No Solvent Coat./Carbon Adsorption/Combination	80-95%	224	Ref. 10, Ref. 15 and ESED	(Same as RACT)	95%	56	ESED
Paint - MEK	40200104	lb/ton solvent in coating	2000	Incineration/Low or No Solvent Coat./Carbon Adsorption/Combination	80-95%	400	Ref. 10, Ref. 15 and ESED	(Same as RACT)	95%	100	ESED
Paint - Solvent General	40200199	lb/ton solvent in coating	2000	Incineration/Low or No Solvent Coat./Carbon Adsorption/Combination	80-95%	400	Ref. 10, Ref. 15 and ESED	(Same as RACT)	95%	100	ESED

DATA REFERENCE:

15. Control of Volatile Organic Emissions from Existing Stationary Sources, Volume I and Volume II (Preprint), U.S. EPA, ESED, Chemical and Petroleum Branch, November, 1976.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBON INDUSTRY POINT SOURCE EVAPORATION -SURFACE COATING (CONT'D)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Solvent - MEK	40200918	lb/ton solvent	2000	Incineration/Low or No Solvent Coat./Carbon Adsorption/Combination	80-95%	400	Ref. 10, Ref. 15 and ESED	(Same as RACT)	95%	100	ESED
Varnish/Shellac-General	40200301	lb/ton coating	1000	Incineration/Low or No Solvent Coat./Carbon Adsorption/Combination	75-95%	250	Ref. 10, Ref. 15 and ESED	(Same as RACT)	95%	50	ESED

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY PETROLEUM PRODUCT STORAGE EVAPORATION

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT* METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT* METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Fixed Roof Breathing-Benzene	40300108	lb/10^3 gal. stg. cap./yr.	18.3	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	90-98.5%	0.68	Ref. 10, 9 & 6	Same as RACT	98.5%	0.27	Ref. 10 9, & 6
Fixed Roof Breathing-Crude Oil	40300102	lb/10^3 gal. stg. cap./yr.	54.8	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	90-98.5%	2.65	Ref. 10, 9 & 6	Same as RACT	98.5%	1.06	Ref. 10 9, & 6
Fixed Roof Breathing-Cyclohexane	40300109	lb/10^3 gal. stg. cap./yr.	20.8	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	90-98.5%	0.76	Ref. 10, 9 & 6	Same as RACT	98.5%	0.30	Ref. 10 9, & 6
Fixed Roof Breathing-Distillate Oil	40300107	lb/10^3 gal. stg. cap./yr.	Very low								
Fixed Roof Breathing-Gasoline	40300101	lb/10^3 gal. stg. cap./yr.	80.3	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	90-98.5%	3.02	Ref. 10, 9 & 6	Same as RACT	98.5%	1.21	Ref. 10 9, & 6

*Internal floating cover also considered RACT and under consideration for LAER.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY PETROLEUM PRODUCT STORAGE EVAPORATION (CONT'D.)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT* METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT* METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Fixed Roof Breathing-Hexane	40300112	lb/10^3 gal. stg. cap./yr.	32.1	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	90-98.5%	1.19	Ref. 10, 9 & 6	Same as RACT	98.5%	0.48	Ref. 10 9 & 6
Fixed Roof Breathing-Jet Fuel	40300105	lb/10^3 gal. stg. cap./yr.	25.2	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	90-98.5%	1.10	Ref. 10, 9 & 6	Same as RACT	98.5%	0.44	Ref. 10 9 & 6
Fixed Roof Breathing-Kerosene	40300106	lb/10^3 gal. stg. cap./yr.	Very low								
Fixed Roof Working-Benzene	40300153	lb/10^3 gal. hruput	2.0	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	~100%	Negligible	Ref. 9	Same as RACT	~100%	Negligible	Ref. 9
Fixed Roof Working-Crude Oil	40300104	lb/10^3 gal. hruput	7.3	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	~100%	Negligible	Ref. 9	Same as RACT	~100%	Negligible	Ref. 9

*Internal floating cover also considered RACT and under consideration for LAER.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY PETROLEUM PRODUCT STORAGE EVAPORATION (CONT'D.)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT* METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT* METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Fixed Roof Working-Cyclohexane	40300154	b/10^3 gal. hruput	2.3	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	~100%	Negligible	Ref. 9	Same as RACT	~100%	Negligible	Ref. 9
Fixed Roof Working-Distillate Oil	40300152	b/10^3 gal. hruput	Very low								
Fixed Roof Working-Gasoline	40300103	b/10^3 gal. hruput	9.0	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	~100%	Negligible	Ref. 9	Same as RACT	~100%	Negligible	Ref. 9
Fixed Roof Working-Hexane	40300157	b/10^3 gal. hruput	3.6	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	~100%	Negligible	Ref. 9	Same as RACT	~100%	Negligible	Ref. 9
Fixed Roof Working-Jet Fuel	40300150	b/10^3 gal. hruput	2.4	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	~100%	Negligible	Ref. 9	Same as RACT	~100%	Negligible	Ref. 9
Fixed Roof Working-Kerosene	40300151	b/10^3 gal. hruput	Very low								

*Internal floating cover also considered RACT and under consideration for LAER.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY PETROLEUM PRODUCT STORAGE EVAPORATION (CONT'D.)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT* METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT* METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Floating Roof Standing-Crude Oil	40300203	lb/10^3 gal. stg. cap./yr.	10.6	Incorporation of tight primary and secondary seals inc. maint. & inspection of seal gaps	75-90%	2.65	Ref. 10	Same as RACT	90%	1.06	Ref. 10
Floating Roof Standing-Gasoline	40300201	lb/10^3 gal. stg. cap./yr.	12.1	Incorporation of tight primary and secondary seals inc. maint. & inspection of seal gaps	75-90%	3.02	Ref. 10	Same as RACT	90%	1.21	Ref. 10
Floating Roof Standing-Jet Fuel	40300205	lb/10^3 gal. stg. cap/yr.	4.38	Incorporation of tight primary and secondary seals inc. maint. & inspection of seal gaps	75-90%	1.10	Assumed from Ref. 10	Same as RACT	90%	0.44	Assumed from Ref. 10
Floating Roof Working-Crude Oil	40300204	lb/10^3 gal. thruput	Negligible	Incorporation of tight primary and secondary seals inc. maint. & inspection of seal gaps		Negligible	Ref. 9	Same as RACT		Negligible	Ref. 9
Floating Roof Working-Gasoline	40300202	lb/10^3 gal. thruput	Negligible	Incorporation of tight primary and secondary seals inc. maint. & inspection of seal gaps		Negligible	Ref. 9	Same as RACT		Negligible	Ref. 9

*Internal floating cover also considered RACT and under consideration for LAER.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY (POINT SOURCE EVAPORATION) PETROLEUM PRODUCT STORAGE (CONT'D)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Fixed Roof Breathing Oxo-Alcohol	40300198	lb/10^3 gal storage cap/yr									
Fixed Roof Breathing - Slop Oil	40300198	lb/10^3 gal storage cap/yr									
Fixed Roof Working - Oxo-Alcohol	40300199	lb/10^3 gal throughput									
Fixed Roof Working - Slop Oil	40300199	lb/10^3 gal throughput									
Floating Roof - Standing Loss - Distillate Fuel	40300207	lb/10^3 gal storage cap/yr	Very low								
Floating Roof - Standing Loss - Light Naphtha	40300299	lb/10^3 gal storage cap/yr	4.38	Incorporation of tight primary and secondary seals including maintenance and inspection of seal gaps*	75-90%	1.10	Ref. 10 (assumed)	Same as RACT*	90%	0.44	Ref. 10 (assumed)
Fixed Roof - Number 6 Oil	40399999	lb/10^3 gal	Very low								
Floating Roof - Standing Loss - Benzene	40300208	lb/10^3 gal storage cap/yr	2.7	Incorporation of tight primary and secondary seals including maintenance and inspection of seal gaps*	75-90%	0.68	Ref. 10 (assumed)	Same as RACT*	90%	0.27	Ref. 10 (assumed)

*Internal floating cover also considered RACT and under consideration for LAER.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY POINT SOURCE EVAPORATION - PRINTING PRESS

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Dryers - General	40500101	lb/ton solvent		Incineration, carbon adsorption or ink substitution	80-90%		Ref. 10	Incineration, carbon adsorption, or ink substitution	90%		Ref. 10
Flexographic - General	40500301	lb/ton ink	1300	Incineration or substitute waterborne inks	80-85%	260	Ref. 10	Incineration or substitute waterborne inks	85%	195	Ref. 10
Flexographic - Ethyl Alcohol & N-Propyl Alcohol	40500304 & 40500306	lb/ton solvent in ink	2000	Incineration or substitute waterborne inks	80-85%	400	Ref. 10	Incineration or substitute waterborne inks	85%	300	Ref. 10
Lithographic - General	40500401	lb/ton ink	700	Incineration carbon adsorption or ink substitution	85-90%	105	Ref. 10	Incineration carbon adsorption or ink substitution	90%	70	Ref. 10
Lithographic - Solvent General	40500499	lb/ton solvent in ink	2000	Incineration, carbon adsorption, or ink substitution	85-90%	300	Ref. 10	Incineration, carbon adsorption, or ink substitution	90%	200	Ref. 10
Gravure - General	40500501	lb/ton ink	1300	Incineration carbon adsorption or ink substitution	85-90%	195	Ref. 10	Incineration carbon adsorption or ink substitution	90%	130	Ref. 10
Gravure - MEK and Solvent General	40500506 & 40500599	lb/ton solvent in ink	2000	Incineration, carbon adsorption, or ink substitution	85-90%	300	Ref. 10	Incineration, carbon adsorption, or ink substitution	90%	200	Ref. 10

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY PETROLEUM MARKETING-TRANSFER

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Marine Vessels-Load(1) Crude Oil	40600202	lb/10^3 gal. trans.	2.58	Submerged fill, slow initial fill, vapor collection & recovery or incineration	90-97%	0.26	Ref. 12 & Ref. 6	Same as RACT	97%	0.087	Ref. 6
Marine Vessels-Load(1) Distillate Oil	40600205	lb/10^3 gal. trans.	Very low								
Marine Vessels-Load(1) Gasoline	40600201	lb/10^3 gal. trans.	2.88	Submerged fill, slow initial fill, vapor collection & recovery or incineration	90-97%	0.26	Ref. 12, 6 & 8	Same as RACT	97%	0.087	Ref. 66 Ref. 8
Marine Vessels-Unload(1) Crude Oil	40600227	lb/10^3 gal. trans.	2.25	Vapor collection & recovery or incineration	90-95%	0.225	Ref. 6	Segregated ballast, disallow in-port purging	100%	0.0	Ref. 8
Marine Vessels-Unload(1) Gasoline	40600226	lb/10^3 gal. trans.	2.52	Vapor collection & recovery or incineration	90-95%	0.225	Ref. 6	Segregated ballast, disallow in-port purging	100%	0.0	Ref. 8
Tank Cars/Trucks-Splash Load Gasoline	40600101	lb/10^3 gal. trans.	12.4	Submerged fill & vapor recovery or incineration	96-99.7%	0.41	Ref. 13, 6 & 3	Bottom loading vapor collection & recovery or incin.	99.7%	0.041	Ref. 13 Ref. 3
Tank Cars/Trucks-Submerged Load Gasoline	40600126	lb/10^3 gal. trans.	4.10	Incineration or vapor recovery	90-99%	0.41	Ref. 13, 6 & 3	Bottom loading vapor collection & recovery or incin.	99%	0.041	Ref. 13 Ref. 3
Tank Cars/Trucks-Unload Gasoline	40600151	lb/10^3 gal. trans.	2.10	Closed loop balance system-recovery at bulk station	90-99%	0.21	Ref. 13, 6 & 3	Closed loop balance system-recovery at bulk station-vapor tight seals on veh.	99%	0.021	Ref. 13 3, & 14

(1) Control Technology for Marine Terminals Available on 4 to 6 Years. Uncontrolled Emission Factor for Barge Unloading is Zero.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NON METHANE HYDROCARBONS INDUSTRY PETROLEUM MARKETING-TRANSFER (CONT'D.)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Marine Vessels-Load(1) Jet Fuel	40600203	lb/10^3 gal trans.	0.60	Submerged fill, slow initial fill, vapor collection & recovery or incineration	57-86%	0.26	Ref. 12, 6 & 8	Submerged fill, slow initial fill, vapor collection & recovery or incineration	86%	0.087	Ref. 6 & Ref. 8
Marine Vessels-Load(1) Kerosene	40600204	lb/10^3 gal trans.	Very low								
Marine Vessels-Load(1) Various Petrochemicals	40600298	lb/10^3 gal trans.		Submerged fill, slow initial fill, vapor collection & recovery or incineration		0.26	Ref. 6	Submerged fill, slow initial fill, vapor collection & recovery or incineration		0.087	Ref. 6
Marine Vessels-Unload Various Petrochemicals (1)	40600299	lb/10^3 gal trans.		Vapor collection and recovery or incineration		0.225	Ref. 6	Segregated ballast, disallow in-port purging	100%	0.0	
Tank Cars/Trucks-Splash Load Distillate	40600105	lb/10^3 gal trans.	Very low								
Tank Cars/Trucks-Splash Load Kerosene	40600104	lb/10^3 gal trans.	Very low								
Tank Cars/Trucks-Splash Load Various Petrochemicals	40600197	lb/10^3 gal trans.		Submerged fill & vapor collection & recovery		0.41	Ref. 6	Submerged fill & vapor collection & recovery		0.041	Ref. 6
Tank Cars/Trucks-Submerged Load Distillate	40600130	lb/10^3 gal trans.	Very low								
Tank Cars/Trucks-Submerged Load Various Petrochemicals	40600198	lb/10^3 gal trans.		Vapor collection & recovery or incineration		0.41	Ref. 6	Vapor collection & recovery or incineration		0.041	Ref. 6

(1) Control Technology for Marine Terminals Available on 4 to 6 Years. Uncontrolled Emission Factor for Barge Unloading is Zero.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY PETROLEUM MARKETING-TRANSFER (CONT'D.)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Tank Cars/Trucks-Unload Distillate	40600155	$lb/10^3$ gal. trans.	Very low								
Tank Cars/Trucks-Unload Various Petrochemicals	40600199	$lb/10^3$ gal. trans.		Closed loop balance system-recovery during loading		0.21	Ref. 6, 13, and 3	Same as RACT		0.21	Ref. 6. 13, and 3

DATA REFERENCES:

12. Background Information on Hydrocarbon Emissions From Marine Terminal Operations, Volumes I and II, Radian Corporation, For U. S. EPA, November 1976.

13. Control of Hydrocarbons From Tank Truck Gasoline Loading Terminals, (Draft), U. S. EPA, ESED, Chemical and Petroleum Branch, May 1977.

14. "The Control of Hydrocarbon Emissions From Gasoline Marketing Operations," Vincent J. Pitruzzello, U. S. EPA, Region II, Paper presented at Mid-Atlantic States Section of the Air Pollution Control Association, April 1977.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY SOLID WASTE

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Government - Municipal Incinerator Multiple Chamber	50100101	lb/ton burned	1.5	None	0%	1.5	ESED	Good design and operating practices	99.9%	negligible	Ref. 20
Government - Municipal Incinerator Single Chamber	50100102	lb/ton burned	15	None	0%	15	ESED	Good design and operating practices	99.9%	negligible	Ref. 20
Industrial - Multiple Chamber Incinerator	50300101	lb/ton burned	3.0	None	0%	3.0	ESED	Good design and operating practices	99.9%	negligible	Ref. 20
Commercial/Institutional - Organic Waste Incinerator	50200505	lb/ton burned									

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY MINOR NON-INDUSTRIAL SOURCES

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
GASOLINE MARKETING Underground tank filling & breathing (service station)		lb/10³ gal throughput	12.5 (splash) 8.3 (submerged)	Service Station (Phase 1) Closed loop balance system & submerged or bottom loading & vapor tight trucks & tight fittings	84(submerged) to 90% (splash)	1.3	Ref. 9, Ref. 3, Ref. 14, & Ref. 17	Same as RACT	84(submerged) to 90% (splash)	1.3	Same as RACT
Vehicle refueling and spillage			9.7	Vehicle Refueling (Phase 2) Manifolded vapor balance system & tight seal at nozzle-tank interface	82-93%	1.8		Same as RACT except improved vehicle refueling efficiency & elimination of spillage	93%	0.7	
Combination			18(submerged) 22.2 (splash)		83-89% (submerged) 86-91% (splash)	3.1			89% (sub merged) 91% (splash)	2.0	
DRY CLEANING Petroleum (Stoddard)		lb/ton clothes cleaned	560	Carbon adsorption & good operating & maintenance practices	82-86%	100	Ref. 9	Same as RACT but better operating & maintenance practices	86%	80	Ref. 9
Perchloroethylene			550	Carbon adsorption & good operating & maintenance practices	81-90%	106	Ref. 9	Same as RACT but better operating & maintenance practices	90%	56	Ref. 9
Trichlorotrifluoroethane			50-90 (controlled)	Refrigeration & operating & maintenance practices	0%	90	Ref. 9	Same as RACT but better operating & maintenance practices	0%	50	Ref. 9

DATA REFERENCE:

17. "A Predictive Model for Estimating the efficiency of Vapor Balance Systems During Vehicle Refueling", J. Panzer, Exxon Research and Engineering Company, Paper presented at Mid-Atlantic States Section the Air Polution Control Association, April 1977.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NON METHANE HYDROCARBONS INDUSTRY MINOR NON-INDUSTRIAL SOURCES (CONT'D)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
ASPHALT PAVING Volatile petroleum distillate evaporation	None	None	Varies with type of cutback	Emulsified asphalt substitution	99%	Negligible	Ref. 10	Same as RACT	Same as RACT	Same as RACT	Same as RACT
SURFACE COATING Not included in point source inventory - architectural	None	None	(2000 lb/ton solvent used)	Low solvent coatings (high solids or water base)	80-90%		Ref. 9 and Ref. 18	Same as RACT	90%		Same as RACT
OPEN BURNING	None	None	Varies with type of material burned	Discontinue practice. Dispose of material in sanitary landfill or with well-controlled incinerator.	99-100% (part. & HC) 65-100% (nitrogen oxides)			Same as RACT	Same as RACT		
ON-SITE INCINERATION	None	None		Discontinue practice. Dispose of material in sanitary landfill or with well-controlled incinerator.	99-100% (part. & HC) 65-100% (nitrogen oxides)			Same as RACT	Same as RACT		

DATA REFERENCE:

18. "Emission Inventory Impact and Cost of Implementation of Proposed Stationary Source Controls", Warren Crouse, Bay Area Air Pollution Control District, August 14, 1977.

APPENDIX D

GROWTH AND RETIREMENT SCHEDULES

METHODOLOGY

Ideally the growth and decline of individual processes should be projected for individual plants and summed over the AQCR. Even the schedule of these events might be significant and also the extreme form of these events, new construction or retirement of facilities. In addition, stationary area sources should be identified where possible and the growing and declining portions should be specified. Projected highway emissions should be related to specific links by land-use and population projections. When a strong source/receptor relationship exists, as in the case of particulates, there is almost no other way to proceed. However, the models relating precursor hydrocarbon emissions to ozone production have no explicit source/receptor relationship, hence alternate, and in a sense cruder, projection techniques could be used. In general, the basic geographic unit considered for projection was the county and the net process growth, rather than the individual plant increases and decreases, was estimated directly.

Point Sources

Point sources were divided into major and minor sources according to whether or not their potential hydrocarbon emissions exceeded 100 tpy.

Major Sources

The LAER emissions for each process in each plant calculated for the base year by the methods outlined in Appendix C were multiplied by a growth factor for the 1976 to 1990 period determined by the method described below. Two summations were made: the sum of emission increases which individually exceeded 50 tpy and those which were individually less than 50 tpy. Those greater than 50 tpy individually were assumed to require offsets under some policy options; the others were not.

Minor Sources

The RACT emissions for each process in each plant calculated for the base year by the methods outlined in Appendix C were multiplied by a growth factor for the 1976 to 1990 period determined by the method described below. These were summed over the AQCR.

Stationary Area Sources

This category includes all emission sources listed in Table D-1 except those under the internal combustion heading. Projected emissions were calculated as the product of a projected activity level and an emission factor. The projected levels of the activity which generate emissions were estimated by assigning a surrogate parameter which would be expected to have a parallel growth rate and for which there were projections of acceptable quality already existing. The surrogate parameter and the source of projection are provided in the table.

In general, the projections of the regional planning group, DVRPC, were used. This, however, necessitated using Salem County and New Castle County data for these county projections, or extending the region of applicability. Salem and New Castle County projections were available only for population and some industrial employment categories.

Mobile Sources

Mobile sources, the internal combustion grouping of Table D-1, includes highway and off-highway components. The projected emissions were calculated as the product of a projected activity level and an emission factor. In the case of highway vehicles, the emission factors were also projected by the Federal Motor Vehicle Control Program providing travel characteristics for the region were specified. Activity levels were projectd by DVRPC except for Salem and New Castle Counties. VMT data for these counties were obtained from the appropriate state transportation department.

The surrogate parameter approach was used for estimating the activity levels of off-highway emission sources, except aircraft. The source of the projection is given in Table D-1. GCA estimates of aircraft landings and take-offs were used directly. However, they were modified in the 1985 to 1990 interval by phasing in new aircraft emission standards which will reduce aircraft hydrocarbon emissions 75% by 1990.

TABLE D-1

AREA SOURCE PROJECTIONS[1]

SOURCE CATEGORY	PROJECTION PARAMETER	PROJECTION SOURCE	GROWTH FACTORS, 1976 TO 1980	1985	1990
Residential Fuel	Households	DVRPC	1.048	1.109	1.171
Comm/Ind. Fuel					
Comm/Inst. Fuel	C/I Emplmt.	DVRPC	1.048	1.109	1.171
Industrial Fuel	Ind. Emplmt.	DVRPC	1.016	1.034	1.049
Incineration	Population	DVRPC	1.020	1.046	1.073
Open Burning	Farm Equipment	DVRPC	1.020	1.046	1.073
Internal Combustion					
Highway Vehicles	FMVCP, VMT	EPA, DVRPC	(See Tables E-6 through E-11)		
Aircraft	LTO's	GCA	1.240	1.550	1.86 (0.44)[2]
Vessels	Population	DVRPC	1.020	1.046	1.073
Railroads	Population	DVRPC	1.020	1.046	1.073
Off-Highway Activity					
Farm Equipment	Agri. Emplmt.	DVRPC	0.912	0.829	0.752
Construction Equip.	Constr. Emplmt.	DVRPC	1.021	1.049	1.074
Lawns & Garden Equip.	Population	DVRPC	1.020	1.046	1.073
Structural Fires	Population	DVRPC	1.020	1.046	1.073
Wild Forest Fires	Negligible base year; expected to remain negligible.				
Agricultural Tilling	Agri. Emplmt.	DVRPC	0.912	0.829	0.752
Unpaved Roads	Dirt Road Miles	E-S	1.000	1.000	1.000
Paved Roads	VMT	DVRPC	1.078	1.168	1.248
Construction	Const. Emplmt.	DVRPC	1.021	1.049	1.074
Surface Coating	Population	DVRPC	1.020	1.046	1.073
Dry Cleaning	Population	DVRPC	1.020	1.046	1.073
Fuel Handling	VMT	DVRPC	1.078	1.168	1.248
Asphalt Paving	No projection	--	(Stabilizing at 20 ton/county/year.		

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(1) Representative of the nine-county DVRPC region.

(2) Modified to reflect new aircraft emission standards which are phased in after 1985.

GROWTH FACTOR ESTIMATION

Point Sources

Industrial Processes

As mentioned above, projections for point sources should be made on as nearly an individual basis as possible. This is rarely possible and a procedure was established which utilized gross data to establish a context in which more specific information could be considered. Obers Series E projections for the Philadelphia SMSA and the projections of Pennsylvania Office of State Planning and Development (OSPD) for the Philadelphia labor market provided the growth factors presented in Table D-2. These factors, for manufacturing earnings and employment by two-digit SIC, were considered to represent the broadest industrial context. Unfortunately, they not only differed according to general level relative to 1976, but they also indicated opposite trends in some instances, such as fabricated metals. Trade journals were consulted for estimates of specific industry activity and in some cases the work of EPA contractors was useful in obtaining specific industry forecasts.

The Penjerdel Corporation, through its Executive Director, Mr. Gardiner Cox, was especially helpful in the effort to obtain industry specific projections. He arranged a meeting between the environmental protection officers of many corporations and Engineering-Science for the purpose of establishing the general economic pictures on an industry-by-industry basis. He circulated a questionnaire soliciting projection information from about 150 high officials in companies with significant emissions. About 45 to 50 useable responses provided the only industry specific projection information available for the AQCR. The range of projections for the various SIC's for which projection data were received is presented in Table D-3. Also shown in the growth rate adopted after consideration of all the non-objective, non-specific data received.

The factors presented in Table D-3 were used in the method described above to calculate emission increments for point sources expected in the 1976 to 1990 interval. New growth, for the hydrocarbon study, was assumed to take place at existing facilities. Alternate growth rates, specifically, the high and low values in Table D-3, were considered in the sensitivity analysis.

TABLE D-2

MANUFACTURING PROJECTIONS

SIC	GROWTH FACTORS, 1976 TO					
	1980		1985		1990	
	EARNINGS	EMPLMT.	EARNINGS	EMPLMT.	EARNINGS	EMPLMT.
20XX - Food & kindred products	1.022	0.979	1.071	0.952	1.124	0.927
22XX - Textile mill products	0.870	0.925	0.820	0.846	0.786	0.781
23XX - Apparel & fabric products	0.914	0.990	0.925	0.979	0.952	0.971
24, 25 - Lumber products & furniture	1.040	1.031	1.115	0.036	1.198	1.051
26XX - Paper & allied products	1.101	0.999	1.250	0.991	1.421	0.983
27XX - Printing & publishing	1.104	0.995	1.251	0.974	1.419	0.945
28XX - Chemical & allied products	1.113	0.995	1.297	0.992	1.516	0.994
29XX - Petroleum refining	1.040	0.935	1.098	0.854	1.161	0.788
33XX - Primary metals	1.013	0.988	1.065	0.958	1.125	0.956
34XX - Fabricated metals	1.013	1.004	1.105	0.998	1.216	0.993
35XX - Machinery, excl. electrical	1.010	1.023	1.106	1.048	1.244	1.050
36XX - Electrical machinery	1.098	1.000	1.270	0.990	1.474	0.969
37XX - Transportation equip.	0.792	1.118	0.805	1.251	0.854	1.391
Total manufacturing	1.037	1.005	1.142	1.003	1.266	1.002

Earnings values are based on OBERS Series E projections for the Philadelphia SMSA.

Employment values are based on Pennsylvania OSPD projections for the Philadelphia labor market area in Pennsylvania.

TABLE D-3

SUMMARY OF INDUSTRIAL GROWTH EXPECTED

SOURCE CATEGORY	REPRESENTATIVE SIC's	RANGE OF PROPOSED(1) 1976-90 GROWTH FACTORS	ADOPTED(2) GROWTH FACTORS
BOILERS			
Electric Utility	4911	1.15	1.15
Others			1.15
CHEMICAL MFG.	28XX	1.01-1.64	1.30
	2818	1.00	
	2821	1.00-1.16	
	2834	1.30	
	2899	"decrease"	
OTHER MFG.		1.05-1.50	1.15
IRON & STEEL PRODUCTION	33XX	.97-1.70	1.30
	3312	0.88-1.38	
	3317	"slow growth"	
	3352	0.80	
PETROLEUM REFINING	2911	1.0-1.20	1.15
CLEANING/SOLVENT	7216, 17, 18	1.0-1.50	1.30
SURFACE COATING	26XX	0.87-1.51	1.30
	34XX	0.80-1.40	1.30
PETROLEUM PRODUCT STORAGE	4226, 2911	1.00-1.20	1.15
PRINTING PRESS	27XX	.947-1.51	1.15
PETROLEUM MKT. & TRFR.	4463, 4214	1.00-1.20	1.15
INCINERATION	4953	----	1.15

(1) The highest and lowest values from one or several of the following sources is listed:
Penjerdel; OBERS, Series E, Pa. OPSD; Trade Journals, summaries of specific industry forecasts; DVRPS publications; Master Siting Studies of the Del. River Basin Comm.; and fuel consumption estimates provided by regional air pollution control agencies.

(2) Growth factor of 1.15 signifies a 15 percent growth through 1990 from base year 1976.

Electric Power Generation

The Master Siting Study Report to: Delaware River Basin Commission (DRBC), June 1975 was consulted. This report has been prepared by representatives of all power generating companies serving the area. It presented the details of all major electric generating projects from 1975 to 1989. This shows that the power demand is expected to double in this interval and the amount of power generated will also double. The generation requirement will be met primarily by new nuclear facilities at the mouth of the Delaware River and on the Upper Schuylkill River. Some new fossil fuel capability will be introduced at the Chester and Eddystone stations where two large coal-burning generators will be installed; however, this increase will be partially offset by retirement of obsolete fossil fueled equipment at nearby sites.

This report was supplemented by fuel consumption estimates prepared for this projection period by the environmental protection officers at the Atlantic City Electric Company and Public Service Electric and Gas Company. These had been prepared for the New Jersey Department of Environmental Protection and represented official projections. Fuel consumption estimates were made by ES for the Philadelphia Electric generating sites based on the proposed schedule of retirements, construction, and changes in ratings given in the DRBC study cited above.

Growth factors for hydrocarbon emissions due to fuel consumption for power generation were estimated in two ways. The total increase in fossil fuel generation capacity for the study period was 10% giving a growth factor of 1.10. The other estimate was based on the direct computation of emissions due to combustion of the estimated fuel requirement in the base year and in 1990. This was preferable to a growth factor derived from the heat content of the fuel required since there were some shifts toward coal and away from distilled oil. The growth in emissions was only 9%, giving a growth factor of 1.09.

A smooth increase over the period was assumed even though two construction steps are detailed in the report: one in 1976, the base year, and the other in 1987-88, toward the study's end. This was because the associated retirement schedule was directly linked to the construction program with the obvious intention of avoiding abrupt changes. However, permitting and/or construction delays could force additional generation of fossil fuel power and probably should be expected. For this reason, the growth factor actually used in this study was 1.15.

Incineration

The amount of material incinerated is a complex function of population, households, and packaging practices. A value of 15% was adopted for the growth factor from 1976 to 1990 for this source. This figure is just under the household growth and just under the population factor doubled, which would represent doubling the amount of solid waste produced per person.

Stationary Area Source

Growth factors were established by first updating the growth factors developed for EPA Region III by GCA. Update was required to adjust the base year from 1974 to 1976. It was also necessary to introduce some change in growth rates to correspond with changes accompanying DVRPC's regional development guidelines, which was adopted subsequent to the GCA report. The growth factors resulting are given in Table D-3. These are average factors for the area which differed only slightly from county to county.

Mobile Sources

The vehicle miles traveled projections provided by DVRPC and the New Jersey (Salem County) and Delaware (New Castle County) transportation departments are presented in Table D-4.

RETIREMENT SCHEDULES

Under the EPA's AQMA guidelines, several procedures were available for estimating plant closings and retirement. The best possible source of specific plant information would be data obtained directly from the owners. However, it was not possible to acquire this data in the detail necessary for a comprehensive investigation of all point sources in the AQCR.

The second methodology recommended in the EPA guidelines suggests the use of Internal Revenue Service (IRS) data. This information establishes

TABLE D-4

PROJECTED VMT IN 1000's/DAY

	1977		1982		1987	
	FRWY	NFRWY	FRWY	NFRWY	FRWY	NFRWY
NEW CASTLE	986	5,589	1,232	6,027	1,429	6,514
BURLINGTON	1,908	3,350	1,989	3,618	2,069	3,886
CAMDEN	1,708	3,721	1,889	3,919	2,071	4,117
GLOUCESTER	1,172	1,543	1,305	1,697	1,438	1,851
MERCER	1,082	2,417	1,160	2,595	1,238	2,772
SALEM	948	1,436	1,018	1,542	1,093	1,656
BUCKS	1,299	4,212	1,396	4,987	1,494	4,761
CHESTER	455	3,685	519	3,975	582	4,264
DELAWARE	605	4,341	664	4,633	722	4,910
MONTGOMERY	1,698	6,474	1,875	6,958	2,053	7,442
PHILADELPHIA	2,304	8,347	2,537	9,505	2,770	10,663
	14,165	45,115	15,583	49,455	16,959	52,836
	59,280		65,038		69,795	

the depreciation (accepted by the U. S. Treasury Department) that is allowed to businesses having specific types of manufacturing processes. The EPA guidelines suggest that the IRS estimate of depreciated time in years be multiplied by two in order to estimate the overall useful life of a specific process. Uncorrected IRS data are summarized in Table D-5 for the industrial categories of major concern in the Philadelphia AQCR.[1] Based on the type of industry prevalent in the Philadelphia area, it would appear that all industry should be completely replaced in 25-35 years. The analysis of this study covered a period of 15 years. Theoretically, about one-half of the industry in the AQCR should be completely replaced in that period.

There are other factors which suggest that the retirement schedules predicted by the IRS would not hold true if certain policies presently being analyzed in this study were in effect. Because of the cost of air pollution control, it may be desirable to operate older equipment longer than normal. In essence, these policies tend to prolong the period over which equipment is normally phased out of operation because of obsolescence.

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[1] Depreciation Guidelines and Rules, U. S. Treasury Dept. IRS Publication No. 456, Washington, D. C., August 1964.

TABLE D-5

ESTIMATED USEFUL LIFE OF VARIOUS FACILITIES AND EQUIPMENT

PROCESS	IRS DEPRECIATION PERIOD (YEARS)	ESTIMATED USEFUL LIFE (YEARS)
Cement Manufacturing	20	40
Chemical and Allied Products	11	22
Fabricated Metal Products	12	24
Feed and Grainmill Products	17	34
Motor Vehicles and Parts	12	24
Paper and Allied Products	16	32
Petroleum Refining	16	32
Petroleum Marketing	16	32
Plastic Products	11	22
Primary Metals	18	36
Stone and Clay Products	15	30

APPENDIX E

BASE YEAR AND PROJECTED EMISSION INVENTORIES

The base year used for this analysis was the calendar year 1976. For the purpose of this study, ES relied principally on various air pollution control agencies to supply the emission inventory for the Philadelphia AQCR. No attempt was made to verify the emissions other than the normal routine checks for consistency that are made in the course of any analysis. The main objective in establishing an inventory was to compile a list of the principal sources of nonmethane hydrocarbon (NMHC) emissions for each individual process in the Philadelphia AQCR.

Insofar as possible, we have tried to use computers in processing the prodigious amount of data collected on each individual process in this area. In some instances, the National Emission Data System (NEDS) computer tape was used as a basis for building the major point source inventory. The NEDS is compatible with the Emission Inventory Subsystem/Permit and Registration (EIS/P&R). ES uses this computer system and a number of auxiliary programs that work off the EIS/P&R master file. The system operates on an IBM 370/168 computer.

Estimating the contribution of fugitive hydrocarbon emissions from point sources has become extremely critical in developing effective control programs for any state or federal control agency. Establishing an inventory for these fugitive emissions is extremely difficult. An inventory may have gaps and it is only as good as measurements made by individual firms. The various air pollution control agencies supplying data for the study area had information on fugitive hydrocarbon emissions for the larger major point sources. These data were incorporated in the major point source inventory.

SOURCE AND QUALITY OF DATA BASE

Emission data were obtained with the assistance of the Philadelphia Air Management Service (AMS), Pennsylvania Department of Environmental Resources (DER), New Jersey Department of Environmental Protection (NJDEP), Delaware Department of Natural Resources and Environmental Control (DNREC), and U.S. Environmental Protection Agency (EPA) Region III. The point source inventories were in four distinct groupings with the following characteristics:

Philadelphia County - The inventory supplied by Philadelphia AMS contained particulate, total hydrocarbon, and nitrogen oxides emission data for 1,022 plants over the period 1971-1976 in NEDS format. Some production information classified as confidential could not be obtained. Major sources are updated annually while minor sources are updated every three years on a rotating basis.

New Castle County - The inventory supplied by Delaware DNREC contained particulate, total hydrocarbon, and nitrogen oxides emission data for 264 plants over the period 1971-1977 in NEDS format. Major sources are updated annually while minor sources are updated every three years on a rotating basis.

New Jersey Counties - The inventories for Burlington, Camden, Gloucester, Mercer, and Salem counties were supplied by NJDEP. These contained particulate, total hydrocarbon, and nitrogen oxides emission data for 148 plants (25, 62, 30, 20, and 11, respectively) for the period 1973-1976 in NEDS format. A recent update of these inventories by ES, under contract to NJDEP, did not complete the updating of all major sources giving these inventories slightly lesser quality than the preceding ones.

External Pennsylvania Counties - The inventories for Bucks, Chester, Delaware, and Montgomery counties were supplied by EPA-Region III which had engaged GCA to update these inventories as of 1974. These contained particulate emission data for 178 plants (46, 27, 37, and 68, respectively) in NEDS format. These were the least adequate inventories, not only because they represented 1974 conditions, but also because some shortcuts appear to have been taken in developing the inventory. For example, different processes were grouped under one source classification code and stack data or production rates were omitted. No hydrocarbon or nitrogen oxides inventories were available for these four counties; however, Pennsylvania DER was in the process of preparing inventories from questionnaires recently provided to industries in these counties. ES generated NEDS inventories based on DER-supplied coding forms in Pennsylvania Emission Data System (PEDS) format for approximately 100 major point source emitters of total hydrocarbons and nitrogen oxides in these four counties. This was 1976 operational data and the inventories should be of high quality.

The only area source inventory for the AQCR which could be found had been prepared by GCA for EPA Region III. This inventory, which contained estimates of particulate, sulfur dioxide, and hydrocarbon emissions in 1974 for each of the 11 counties, was made available and utilized as a base for this study. Updating to 1976 was required for all sources. Revision of emission estimates for unpaved roads, construction, open burning, and incineration categories was necessary, as was generation of estimated emissions from structural fires, paved roads, and asphalt paving.

Emissions from highway vehicles were prepared by EPA's Emission Standards and Engineering Division (ESED) under the guidance of the project officer for this study and based upon projections of vehicle miles of travel (VMT) provided by the Delaware Valley Regional Planning Commission (DVRPC) for 1977, 1982, and 1987. The DVRPC projections for 1982 and 1987 did not include data for Salem and New Castle Counties; however, VMT projections for New Castle County were obtained from the Delaware Department of Transportation (DOT) and 1976 link analysis data for Salem County were made available by the New Jersey DOT. The EPA's ESED based Salem's future VMT estimates on the projections for Burlington and Gloucester Counties.

Projection techniques for point and area sources are discussed thoroughly in Appendix D.

NONMETHANE HYDROCARBON EMISSIONS - BASE YEAR AND PROJECTED

Point Sources

The point source inventory contained estimates of total hydrocarbon emissions from approximately 1,250 plants. ES's first task was to remove from consideration those processes which emitted mainly methane. Additional investigation revealed that petroleum storage facilities in some instances had excessive evaporation losses when processing residual oil. These were modified accordingly. Other obvious errors were adjusted based on throughput and size. Finally, emission estimates for fixed and floating roof petroleum storage tanks based on the American Petroleum Institute (API) method have been shown to be too high by a factor of 2 to 3 in independent studies by ES, Chicago Bridge and Iron, and Western Oil and Gas Association. Emissions from these point sources were reduced accordingly: 60% if fixed roof;

50% if floating. The adjusted point source inventory representing the best estimate of actual NMHC emissions from point sources in 1976 is summarized in Table E-1.

In Table E-1, emissions from major point sources, those with the potential of emitting 100 tpy or more NMHC in 1976, are tabulated separately. They comprise 90.7% of the total point source inventory, 152,001 tpy out of 167,569 tpy. Emissions were organized by source category to facilitate application of control technology (Appendix C) and growth factors (Appendix D). Most of the emissions are seen to be associated with chemical manufacturing; petroleum refining, storage, and marketing; and solvent evaporation associated with surface coating and cleaning.

The effect of control technology and the expected growth in emissions during the study period is also shown in Table E-1. Note that RACT reduces emissions from 167,569 tpy to 36,742 tpy; LAER would further reduce emissions to 21,351 tpy. Major source growth was found by applying growth factors to the emissions of the individual processes (Appendix D). When a major process emission (at RACT or LAER) times the growth factor exceeded 50 tpy, this was tabulated separately since offset policies would probably be required at this level of emission increase. Note that this assumes that no minor source will become a major source in the study period, although major sources will have "minor" growth as tabulated in the <50 tpy column. Major source growth was expected to be at LAER, whether or not it exceeds 50 tpy; however, a RACT column was tabulated for comparison. Minor source growth at RACT was assumed.

Stationary Area Sources

Area sources may be point sources too numerous and small to tabulate; examples include line sources such as roads which form a network or area sources such as brush fires. In the case of hydrocarbons, the primary sources are the combustion and evaporation processes. Guidelines for preparing emission inventories on an annual basis at the county level have been prepared by EPA[1] and followed in this study to the degree practicable.

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[1] EPA-450/2-77-028, Dec. 1977. Procedures for the Preparation of Emission Inventories for Volatile Organic Compounds, Vol. I OAQPS, RTP, NC 27711.

TABLE E-1

BASE YEAR AND PROJECTED NONMETHANE HYDROCARBON EMISSIONS FROM POINT SOURCES WITH VARIOUS CONTROL TECHNOLOGY

INDUSTRY/PRODUCT/PROCESS	1976 EMISSIONS (TPY)				EMISSIONS ADDED BY 1990 (TPY)			
	MAJOR[1] SOURCES	MINOR SOURCES	ALL SOURCES		MAJOR SOURCES (LAER)			MINOR (RACT)
			RACT	LAER	≥50 TPY[2]	<50 TPY	IF RACT[3]	
BOILERS								
Electric Utility	107	944	1,051	7	0	0	16	158
Industrial	834	626	945	605	0	0	3	198
Commercial/Institutional	0	134	134	33	0	0	0	60
STATIONARY INTERNAL COMBUSTION	0	326	326	10	0	0	0	2
CHEMICAL MANUFACTURING								
Chlorine	323	5	328	328	97	0	97	2
Cleaning Chemicals	193	0	193	193	58	0	58	0
Paint Manufacturing	115	103	15	15	0	2	2	0
Varnish Manufacturing	158	6	9	9	0	2	2	0
Plastics	1,078	152	452	330	0	74	105	21
Phthalic Anhydride	700	0	70	7	0	2	21	0
Printing Ink	0	80	8	8	0	0	0	2
Synthetic Rubber	730	290	117	108	0	21	21	12
Adhesives	44	438	123	12	0	1	12	11
Sulfonic Acid	1,244	26	15	15	356	17	373	8
All Other Chemical Manufacturing	5,436	724	6,160	6,160	743	153	896	226

TABLE E-1 (Continued)

BASE YEAR AND PROJECTED NONMETHANE HYDROCARBON

EMISSIONS FROM POINT SOURCES WITH VARIOUS CONTROL TECHNOLOGY

INDUSTRY/PRODUCT/PROCESS	1976 EMISSIONS (TPY)				EMISSIONS ADDED BY 1990			
	MAJOR SOURCES	MINOR SOURCES	ALL SOURCES		MAJOR SOURCES (LAER)			MINOR (RACT)
			RACT	LAER	≥50 TPY	<50 TPY	IF RACT	
OTHER MANUFACTURING	23	287	310	310	0	4	4	40
IRON & STEEL PRODUCTION								
Coke Met. By-Products	3,466	164	725	306	0	43	168	1
Iron Production	0	25	25	25	0	0	0	7
PETROLEUM REFINING								
Process Heater	0	530	18	17	0	0	0	7
Fluid Crackers	4,499	0	112	90	0	13	17	0
Movable Bed Catalytic Cracker	4	0	4	4	0	1	1	0
Blow-Down System	2,025	0	34	34	0	10	10	0
Process Drains	14,279[4]	0	1,090	1,090	122	41	163	0
Vacuum Jets	1,899	0	1	1	0	0	0	0
Cooling Towers	798	64	28	28	0	12	12	1
Miscellaneous Fugitive Emissions (flanges, valves, seals, etc.)	15,005	51	655	559	0	133	156	0
Flares	283	0	283	283	0	42	42	0
Asphalt Oxidizer	8	0	0	0	0	0	0	0
All Others	653	4	657	657	77	57	146	2

TABLE E-1 (Continued)

BASE YEAR AND PROJECTED NONMETHANE HYDROCARBON
EMISSIONS FROM POINT SOURCES WITH VARIOUS CONTROL TECHNOLOGY (Continued)

INDUSTRY/PRODUCT/PROCESS	1976 EMISSIONS (TPY)				EMISSIONS ADDED BY 1990			
	MAJOR SOURCES	MINOR SOURCES	ALL SOURCES		MAJOR SOURCES (LAER)			MINOR (RACT)
			RACT	LAER	≥50 TPY	<50 TPY	IF RACT	
CLEANING/SOLVENT								
Dry Cleaning	70	47	10	8	0	1	1	3
Degreasing	228	701	494	274	0	11	14	107
SURFACE COATING								
Paper & Allied Products	15,487	422	2,865	1,103	0	228	591	22
Misc. Plastic Products	4,339	156	360	46	0	12	95	0
Fabricated Metals	7,626	608	6,034	1,408	169	17	922	34
Transportation Equipment	7,835	904	1,571	405	105	76	710	60
All Others	2,562	3,734	2,426	1,238	124	27	196	162
PETROLEUM PRODUCT STORAGE[5]								
Fixed Roof	45,012[6]	503	4,530	2,768	229	93	577	108
Floating Roof	1,558	901	2,120	1,822	0	265	301	75
Variable Vapor Space	8	0	8	2	0	0	1	0
All Others	0	514	103	13	0	0	0	165
PRINTING PRESS	6,901	996	1,398	900	0	179	281	34

TABLE E-1 (Continued)

BASE YEAR AND PROJECTED NONMETHANE HYDROCARBON EMISSIONS FROM POINT SOURCES WITH VARIOUS CONTROL TECHNOLOGY

INDUSTRY/PRODUCT/PROCESS	1976 EMISSIONS (TPY)				EMISSIONS ADDED BY 1990			
	MAJOR SOURCES	MINOR SOURCES	ALL SOURCES		MAJOR SOURCES (LAER)			MINOR (RACT)
			RACT	LAER	≥50 TPY	<50 TPY	IF RACT	
PETROLEUM MARKETING & TRANSFER								
Tank Cars, Trucks	204	81	91	33	0	3	25	6
Marine Vessels	6,267	0	328	63	0	9	45	0
INCINERATION								
Government	0	917	492	0	0	0	0	98
Industrial	0	100	24	24	0	0	0	16
TOTALS	152,001	15,568	36,742[7]	21,351[8]	2,080	1,549	6,084	1,648

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[1] Major sources have potential emissions ≥100 tons per year in the base year, 1976.

[2] All major source growth requires LAER. In addition, new source growth which has emissions in excess of 50 tons per year requires offsets

[3] Emissions in this column represent incremental major source emissions if a RACT SIP were promulgated.

[4] This figure will be reduced by 8,957 tons per year in 1978 when one major source complies with the present SIP. This difference is not available as an offset.

[5] Emissions reported in this category have been multiplied by a factor of 0.4 or 0.5 (fixed and floating roof tanks, respectively) because tests by ES and others have demonstrated that estimates based on the API technique are too high by this factor, or more.

[6] This figure will be reduced by 41,292 tons per year in 1978 when one major source complies with the present SIP. This difference is not available as an offset.

[7] RACT offsets were subsequently calculated by subtracting these emissions from the sum of the emissions in the first two columns: 80,581 tpy, of which 7,785 are from minor sources.

[8] LAER offsets are the difference between these emissions and RACT emissions: 15,391 tpy.

The GCA inventory for 1974 prepared for EPA Region III, however, was the basic source of marketing information or activity levels in this study since neither time nor funds could be allocated to basic data collection. Of course, when emissions from sources not considered by GCA were estimated, such as cutback asphalt paving, then minimal basic information was solicited from and provided by the three transportation departments.

The base and projected years stationary area source hydrocarbon emissions are presented by source category and by county in Tables E-2 through E-5. Note that emissions total 46,534 tpy in 1976 or about one-forth of the point source emissions; by 1990 they are expected to grow to 55,106 tpy or about one-third of the point source inventory. The potential for reducing emissions (see Table III-2) and appropriate control technology is discussed in Appendix C. The projection techniques are discussed in Appendix D. Because the estimation techniques are rather imprecise, no attempt was made to distinguish between methane and nonmethane area emissions, though primarily methane sources were ignored.

Mobile Sources

Mobile sources consist of highway vehicles and off-highway vehicles. Separate estimation and projection procedures were used for each.

Highway vehicles emission estimates were prepared by considering basic VMT data provided by the DVRPC, Delaware DOT, and New Jersey DOT as mentioned previously. The VMT provided by DVRPC and the Delaware and New Jersey DOT's are given in Table D-4. EPA's Mobile I emission factor program was then used to determine nonmethane hydrocarbon and nitrogen oxides emissions using national average vehicle mix data and travel weighing factors, average speed data for the two road classes (35 mph of freeway, 15 mph non-freeway), the hot-cold start percentages used in the Federal Test Procedure, and the appropriate annual temperature and humidity. Actually, total hydrocarbons were computed and the methane fraction estimated and deducted by assuming the fraction of pre- and post-control (1974 and 1982 model years) vehicles in operation for each calculation year. The product of VMT and the Mobile I emission factor is presented in Table E-6.

The off-highway segment consisted of railroads, aircraft, river vessels, farm tractors, and heavy construction equipment. These source categories had

TABLE E-2

1976 HYDROCARBON EMISSIONS FROM STATIONARY AREA SOURCES (tons/year)

	REGION	NEW CASTLE	BURLINGTON	CAMDEN	GLOUCESTER	MERCER	SALEM	BUCKS	CHESTER	DELAWARE	MONTGOMERY	PHILADELPHIA
RESIDENTIAL FUEL	1,560	70	60	100	35	70	10	80	65	120	150	800
COMM./IND. FUEL	773	30	30	60	8	60	5	50	35	65	120	310
OPEN BURNING	460	40	55	5	45	35	55	75	100	5	45	0
INCINERATION	140	10	8	10	4	8	2	10	8	15	15	50
STRUCTURAL FIRES	236	15	15	20	8	15	3	20	10	25	25	80
AGRICULTURAL TILLING	0	0	0	0	0	0	0	0	0	0	0	0
CONSTRUCTION	0	0	0	0	0	0	0	0	0	0	0	0
UNPAVED ROADS	0	0	0	0	0	0	0	0	0	0	0	0
PAVED ROADS	0	0	0	0	0	0	0	0	0	0	0	0
FUEL HANDLING	26,290	2,100	1,600	2,300	920	1,500	370	1,900	1,200	2,700	2,800	8,900
SOLVENT EVAPORATION	10,090	700	620	870	340	540	110	780	530	1,100	1,100	3,400
DRY CLEANING	5,735	390	360	490	200	300	65	450	300	620	660	1,900
ASPHALT PAVING	1,250	900	50	50	50	50	50	20	20	20	20	20
TOTAL	46,534	4,255	2,798	3,905	1,610	2,578	670	3,385	2,268	4,670	4,935	15,460

TABLE E-3

1980 HYDROCARBON EMISSIONS FROM STATIONARY AREA SOURCES (tons/year)

	REGION	NEW CASTLE	BURLINGTON	CAMDEN	GLOUCESTER	MERCER	SALEM	BUCKS	CHESTER	DELAWARE	MONTGOMERY	PHILADELPHIA
RESIDENTIAL FUEL	1,645	70	70	110	40	75	10	90	70	130	160	820
COMM./IND. FUEL	798	30	30	65	8	65	5	50	35	70	120	320
OPEN BURNING	2,183	170	250	35	210	140	260	360	520	25	210	3
INCINERATION	140	10	8	10	4	8	2	10	8	15	15	50
STRUCTURAL FIRES	236	15	15	20	8	15	3	20	10	25	25	80
AGRICULTURAL TILLING	0	0	0	0	0	0	0	0	0	0	0	0
CONSTRUCTION	0	0	0	0	0	0	0	0	0	0	0	0
UNPAVED ROADS	0	0	0	0	0	0	0	0	0	0	0	0
PAVED ROADS	0	0	0	0	0	0	0	0	0	0	0	0
FUEL HANDLING	28,400	2,300	1,700	2,400	1,000	1,600	400	2,000	1,300	2,900	3,000	9.800
SOLVENT EVAPORATION	10,350	710	650	900	360	560	120	810	540	1,200	1,200	3,400
DRY CLEANING	5,850	400	370	500	210	310	70	470	310	630	680	1,900
ASPHALT PAVING	250	50	20	20	20	20	20	20	20	20	20	20
TOTAL	49,852	3,755	3,113	4,060	1,860	2,793	890	3,830	2,813	4,915	5,430	16,393

TABLE E-4

1985 HYDROCARBON EMISSIONS FROM STATIONARY AREA SOURCES (tons/year)

	REGION	NEW CASTLE	BURLINGTON	CAMDEN	GLOUCESTER	MERCER	SALEM	BUCKS	CHESTER	DELAWARE	MONTGOMERY	PHILADELPHIA
RESIDENTIAL FUEL	1,750	80	70	120	45	85	10	95	75	140	180	850
COMM./IND. FUEL	841	35	35	70	10	65	6	55	35	70	130	330
OPEN BURNING	1,743	120	210	30	170	120	180	280	440	20	170	3
INCINERATION	143	10	9	10	5	9	2	10	8	15	15	50
STRUCTURAL FIRES	237	15	15	20	9	15	3	20	10	25	25	80
AGRICULTURAL TILLING	0	0	0	0	0	0	0	0	0	0	0	0
CONSTRUCTION	0	0	0	0	0	0	0	0	0	0	0	0
UNPAVED ROADS	0	0	0	0	0	0	0	0	0	0	0	0
PAVED ROADS	0	0	0	0	0	0	0	0	0	0	0	0
FUEL HANDLING	30,950	2,500	1,800	2,600	1,100	1,800	450	2,100	1,400	3,000	3,200	4,000
SOLVENT EVAPORATION	10,600	790	680	930	390	580	130	850	550	1,100	1,200	3,400
DRY CLEANING	6,045	400	390	530	220	330	75	490	320	640	710	1,900
ASPHALT PAVING	220	20	20	20	20	20	20	20	20	20	20	20
TOTAL	52,529	4,010	3,229	4,330	1,969	3,024	876	3,920	2,858	5,030	5,650	17,633

TABLE E-5

1990 HYDROCARBON EMISSIONS FROM STATIONARY AREA SOURCES (tons/year)

	REGION	NEW CASTLE	BURLINGTON	CAMDEN	GLOUCESTER	MERCER	SALEM	BUCKS	CHESTER	DELAWARE	MONTGOMERY	PHILADELPHIA
RESIDENTIAL FUEL	1,825	85	80	130	50	80	10	100	80	140	190	880
COMM./IND. FUEL	876	35	35	70	10	70	6	55	40	75	130	350
OPEN BURNING	1,557	100	190	25	160	110	150	240	400	20	160	2
INCINERATION	144	10	9	10	5	9	2	10	9	15	15	50
STRUCTURAL FIRES	264	20	20	25	10	15	4	25	10	25	30	80
AGRICULTURAL TILLING	0	0	0	0	0	0	0	0	0	0	0	0
CONSTRUCTION	0	0	0	0	0	0	0	0	0	0	0	0
UNPAVED ROADS	0	0	0	0	0	0	0	0	0	0	0	0
PAVED ROADS	0	0	0	0	0	0	0	0	0	0	0	0
FUEL HANDLING	33,190	2,800	2,000	2,700	1,200	1,700	490	2,200	1,500	3,200	3,400	12,000
SOLVENT EVAPORATION	10,820	840	710	970	410	600	130	890	570	1,100	1,200	3,400
DRY CLEANING	6,210	470	410	550	240	340	80	510	330	650	730	1,900
ASPHALT PAVING	220	20	20	20	20	20	20	20	20	20	20	20
TOTAL	55,106	4,380	3,474	4,500	2,105	2,944	892	4,050	2,959	5,245	5,875	18,682

TABLE E-6

PHILADELPHIA NONMETHANE HYDROCARBON MOTOR VEHICLE EMISSIONS

		Non Freeway 15 mph			Freeway 35 mph			Total			
		10^3 mi/day						10^3 gms/day	tons/year		
YEAR	PROGRAM	NFRWY VMT	E F	EMISSIONS	FRWY VMT	E F	EMISSIONS	TOTAL EMISSIONS	TOTAL EMISSIONS	10% TCP	20% TCP
1977	No I&M	45,115	9.98	450,248	14,165	5.84	82,724	532,972	214,718		
	Weak I&M	45,115	9.98	450,248	14,165	5.84	82,724	532,972	214,718		
	Strong I&M	45,115	9.98	450,248	14,165	5.84	82,724	532,972	214,718		
1982	No I&M	49,455	6.00	296,730	15,583	3.25	50,645	347,375	139,947	125,952	
	Weak I&M	49,455	5.58	275,959	15,583	3.05	47,528	323,487	130,323	117,291	
	Strong I&M	49,455	5.42	268,046	15,583	2.97	46,281	314,327	126,633	113,970	
1987	No I&M	52,836	3.46	182,813	16,959	1.70	28,830	211,643	85,264	76,738	68,211
	Weak I&M	52,836	2.71	143,186	16,959	1.34	22,725	165,911	66,840	60,156	53,472
	Strong I&M	52,836	2.58	136,317	16,959	1.28	21,707	158,024	63,663	57,297	50,930
1990	No I&M	55,102	2.96	163,102	17,685	1.39	24,582	187,684	75,612	68,051	60,490
	Weak I&M	55,102	2.15	118,469	17,685	1.00	17,685	136,154	54,852	49,367	43,882
	Strong I&M	55,102	2.07	114,061	17,685	.96	16,978	131,039	52,792	47,513	42,234

General
Region: 1
PCCO: 21%
PCHS: 27%
PCCC: 21%
SPD: (1)

Weak I&M
Initiate: 1980
Stringency: 15%
Mechanic training: yes
Model years: 1950 - 1990

Strong I&M
Initiate: 1980
Stringency: 30%
Mechanic training: yes
Model years: 1950 - 1990

been included in GCA's area source inventory. Simple updates were made to account for changed activity levels in the later base year, 1976. More extensive revision was required for the projected emissions because DVRPC had modified its projections of surrogate parameters since GCA's inventory was made.

Tables E-7 through E-10 contain the estimates of mobile source emissions in the base years, 1980, 1985, and 1990. Note that they comprise 252,410 tpy or one and one-half times the point source emissions in the base year; with the FMVCP alone they comprise 93,537 tpy in 1990 which is a reduction of 63%. Additional control programs are possible and their probable impact is included in the tables at the earliest date these programs could be implemented in the view of EPA's ESED. The inspection/maintenance (I/M) program was considered to be adopted in 1980. The weak program had 15% stringency; the strong, 30%. Both were assumed to include mechanics training. A 10% transportation control program was assumed to be adopted in 1982; a 20% program in 1987. Note that a change in aircraft emissions is phased-in beginning in 1985 and is responsible for the reduction in off-highway emissions in 1990.

TABLE E-7

1976 HYDROCARBON EMISSIONS FROM MOBILE SOURCES (tons/year)

	REGION	NEW CASTLE	BURLINGTON	CAMDEN	GLOUCESTER	MERCER	SALEM	BUCKS	CHESTER	DELAWARE	MONTGOMERY	PHILADELPHIA
HIGHWAY VEHICLES[1]												
FMVCP ONLY[2]	229,672	25,438	20,499	21,151	10,499	13,620	9,282	21,088	16,078	19,266	31,768	40,983
FMVCP & WEAK I/M												
FMVCP & STRONG I/M												
FMVCP & STRONG I/M + 10% TCP												
FMVCP & STRONG I/M + 20% TCP												
OFF-HIGHWAY VEHICLES												
FARM & CONSTRUCTION	11,665	650	490	720	270	480	95	1,100	660	1,400	1,500	4,300
RAILROADS	2,735	45	120	170	70	115	35	265	170	340	365	1,040
AIRCRAFT OPERATIONS	7,636	585	2,200	20	105	940	15	310	580	6	570	2,305
VESSELS	702	140	25	65	105	2	245	0	0	25	0	95
SUBTOTAL	22,738	1,420	2,835	975	550	1,537	390	1,675	1,410	1,771	2,435	7,740

NOTES: [1] Nonmethane hydrocarbons

[2] No other control programs were in effect.

TABLE E-8

1980 HYDROCARBON EMISSIONS FROM MOBILE SOURCES (tons/year)

	REGION	NEW CASTLE	BURLINGTON	CAMDEN	GLOUCESTER	MERCER	SALEM	BUCKS	DELAWARE	DELAWARE	MONTGOMERY	PHILADELPHIA
HIGHWAY VEHICLES[1]												
FMVCP ONLY	169,855	19,111	14,782	15,311	7,427	9,985	6,758	15,826	11,837	13,947	23,277	31,682
FMVCP & WEAK I/M	164,081	18,462	14,280	14,790	7,174	9,559	6,528	15,288	11,436	13,473	22,486	30,605
FMVCP & STRONG I/M	161,867	18,213	14,087	14,591	7,078	9,430	6,440	15,082	11,281	13,291	22,182	30,192
FMVCP & STRONG I/M + 10% TCP[2]												
FMVCP & STRONG I/M + 20% TCP[2]												
OFF-HIGHWAY VEHICLES												
FARM & CONSTRUCTION	11,280	280	620	480	710	270	90	1,000	640	1,300	1,500	4,200
RAILROADS	2,785	45	125	175	70	115	35	280	175	345	375	1,045
AIRCRAFT OPERATIONS	9,282	730	2,725	25	130	1,165	15	385	720	7	710	2,670
VESSELS	722	140	25	65	110	2	255	0	0	30	0	95
SUBTOTAL	24,069	1,535	3,355	975	580	1,752	395	1,665	1,535	1,682	2,585	8,010

NOTES: [1] Nonmethane hydrocarbons

[2] This program cannot be put into effect as early as 1980.

TABLE E-9

1985 HYDROCARBON EMISSIONS FROM MOBILE SOURCES (tons/year)

	REGION	NEW CASTLE	BURLINGTON	CAMDEN	GLOUCESTER	MERCER	SALEM	BUCKS	CHESTER	DELAWARE	MONTGOMERY	PHILADELPHIA
HIGHWAY VEHICLES[1]												
FMVCP ONLY	107,137	12,102	9,178	9,525	5,009	6,167	4,218	9,951	7,425	8,676	14,565	20,321
FMVCP & WEAK I/M	92,233	10,419	7,901	8,200	4,312	5,309	3,631	8,567	6,392	7,469	12,539	17,494
FMVCP & STRONG I/M	88,851	10,037	7,611	7,899	4,154	5,114	3,498	8,253	6,157	7,195	12,079	16,852
FMVCP & STRONG I/M + 10% TCP	79,966	9,033	6,850	7,109	3,738	4,603	3,148	7,427	5,542	6,476	10,871	15,167
FMVCP & STRONG I/M + 20% TCP [2]												
OFF-HIGH VEHICLES												
FARM & CONSTRUCTION	11,010	620	470	690	260	460	90	1,000	620	1,300	1,400	4,100
RAILROADS	2,855	50	130	180	75	120	35	295	180	355	390	1,045
AIRCRAFT OPERATIONS	11,435	915	3,415	35	160	1,460	20	480	900	10	890	3,150
VESSELS	752	145	25	70	115	2	270	0	0	30	0	95
SUBTOTAL	26,052	1,730	4,040	795	610	2,042	415	1,775	1,700	1,695	2,680	8,390

NOTES: [1] Nonmethane hydrocarbons.

[2] This program cannot be put into effect as early as 1985.

TABLE E-10

1990 HYDROCARBON EMISSIONS FROM MOBILE SOURCES (tons/year)

	REGION	NEW CASTLE	BURLINGTON	CAMDEN	GLOUCESTER	MERCER	SALEM	BUCKS	CHESTER	DELAWARE	MONTGOMERY	PHILADELPHIA
HIGHWAY VEHICLES[1]												
FMVCP ONLY	75,612	8,694	6,415	6,677	3,603	4,333	2,980	6,431	5,264	6,071	10,296	14,848
FMVCP & WEAK I/M	54,852	6,307	4,654	4,844	2,614	3,143	2,162	4,665	3,819	4,404	7,469	10,772
FMVCP & STRONG I/M	52,792	6,070	4,479	4,662	2,516	3,025	2,080	4,490	3,675	4,239	7,189	10,367
FMVCP & STRONG I/M + 10% TCP	47,513	5,463	4,031	4,196	2,264	2,723	1,872	4,041	3,308	3,815	6,470	9,330
FMVCP & STRONG I/M + 20% TCP	42,234	4,856	3,583	3,730	2,013	2,420	1,664	3,592	2,940	3,391	5,751	8,294
OFF-HIGHWAY VEHICLES												
FARM & CONSTRUCTION	10,820	630	460	680	260	460	90	950	590	1,300	1,400	4,000
RAILROADS	2,925	50	135	190	80	125	40	310	185	360	405	1,045
AIRCRAFT OPERATIONS[2]	3,393	275	1,025	10	50	440	5	145	270	3	265	905
VESSELS	787	155	25	70	125	2	285	0	0	30	0	95
SUBTOTAL	17,925	1,110	1,645	950	515	1,027	420	1,405	1,045	1,693	2,070	6,045

NOTES: [1] Nonmethane hydrocarbons.

[2] Reflects compliance with new aircraft emission standards.

APPENDIX F

GLOSSARY OF TERMS

1. Inspection and Maintenance (I/M): This is an inspection and maintenance program of automobiles to ensure they are in compliance with the Federal Motor Vehicles Emissions Control Program.

2. Lowest Achievable Emission Rate (LAER): LAER is defined in the 1977 Amendments to the Clean Air Act as the more stringent of the lowest emission rates achieved in practice of the lowest SIP emission limitation achievable for a class or category of sources. It is currently required of all major new or modified sources requesting permissiton to construct in nonattainment areas. It will continue to be required by all states in nonattainment areas until NAAQS are achieved and maintained.

3. Major Stationary Source: Only new or modified "major" stationary sources are subject to the offset ruling or the Act's new nonattainment requirements. A new source or modification of an existing source is deemed to be a major source if it has the potential to emit (or increase emissions by) 100 tons per year or more of any pollutant. However, under EPA regulations, such sources which emit 50 tons per year or more after control will be subject to the offset ruling and Clean Air Act requirements.

4. National Ambient Air Quality Standards (NAAQS): EPA has established standards of permissible air quality concentrations of sulfur dioxide, particulate matter, ozone, carbon monoxide, and nitrogen dioxide. A standard was also established for hydrocarbon levels for use only as a guideline for the control of ozone. Primary standards protect the public health while secondary standards protect public welfare.

5. Nonattainment Area: An area which is shown by monitored data or which is calculated by air quality modeling to violate a NAAQS.

6. Offset Policy: EPA's December 21, 1976 interpretive ruling on growth in nonattainment areas. This ruling, which is continued by the 1977 amendments until July 1, 1979, requires that new emissions in such areas must be more than "offset" by concurrent emission reductions from existing sources in the area. The policy also provides that such new emissions must be reduced to the lowest achievable emission rate (LAER) and that credit for reductions from existing sources will be allowed only to the extent that they go beyond what the applicable SIP already requires. The combination of LAER and offsets must lead to a net air qualty improvement.

7. Potential Emissions: This is the level of emissions which would be generated if the source were operated at its design capacity without control equipment. At the present time, EPA's offset policy is phrased in terms of "allowable emissions", which clearly looks to the level of emissions after controls. EPA will incorporate this change into the existing offset policy even before the July 1979 deadline for SIP revisions.

8. Reasonable Available Control Technology (RACT): RACT is the level of pollution control technology on existing sources which takes both cost and technology into account. By law, it is the level of control that the states will adopt in revised implementation plans in 1979 subject to EPA approval. In some instances, it will provide for attainment of standards by 1982. In others, it will be more stringent at the state's discretion in order to provide an additional margin for growth.

9. Reasonable Further Progress (RFP): A requirement which must be included in the states' revised implementation plans for nonattainment areas. The term refers to annual incremental emission reductions which are sufficient to demonstrate attainment of the ambient air quality standards by the new 1982 deadline of 1987 extension. At a minimum, RFP requires emission reductions from existing sources as may be obtained through the adoption of "Reasonably Available Control Technology" (RACT).

10. State Implementation Plan (SIP): Each state is required to submit for EPA's approval, an implementation plan outlining the state's strategy for attaining and maintaining the NAAQS within the deadlines established by the Clean Air Act.